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Envy of the Rich

IF THE race is to progress and the condition of the average man is to improve, there must be leaders who will show the way.

It is inconceivable that progress should proceed along a smooth, unbroken front. There will always be those who, with greater talent, more diligence and application and foresight, will forge ahead in the struggle for success.

And the more of them who get on, the better it will be for human progress, the better will be the estate of the average man, provided that they get on by legitimate means and not by exploiting and imposing upon their fellows.

Nobody has any execrations for the man who makes good time upon the road because he knows the best routes and the short cuts and has had the precaution to go over his car and get it into thorough running order before he starts, so that he can keep going.

It is the hog who edges in, who forces others to stand aside and let him by to save their own necks, who gets through by selfish aggression and reckless disregard for the rights of others, who incurs the general hatred.

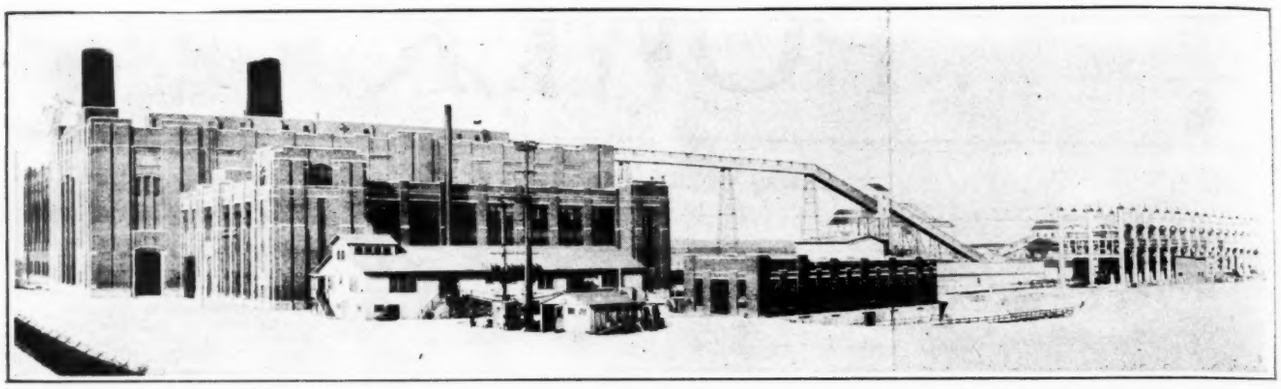
And so it is in industrial and social life. No right-minded man has any envy or hatred for the man who has achieved eminence and riches by legitimate means; by inventions or discovery or the development of enterprises that have made possible the greater physical comfort and cultural enjoyment of modern man.

The man who risks his fortune and endeavor in some great adventure upon the uncharted sea of a new industry and succeeds, multiplying the opportunities of the toiler, producing a new advantage to the consumer in desirable commodities or service, is a benefactor and entitled to the fruits of his faith, initiative and daring.

The man who discovers a new material or process or who invents a device that lightens human toil or adds to human comfort and enjoyment is not begrudged the returns that it brings to him.

It is the man who rides to riches upon the necessities and misfortunes of others, through extortion, exploitation and the validation of patches of blue sky, without having rendered an equivalent service, who is responsible for the popular enmity against great wealth.

F. R. Low



This station includes most of the latest improvements in steam power-plant practice

Crawford Avenue Station of the Commonwealth Edison Company

INITIAL installation of a 750,000-kw. plant consists of three units now in operation and a fourth going in, with an aggregate capacity of 235,000 kw. Steam conditions of 550 lb. gage and 725 deg. F. are used as well as reheating, stage bleeding, water and air economizers, vertical condensers, direct drive of auxiliary generators and exciters and motor-driven auxiliaries.

IN THE studies that were made to determine upon the operating conditions for the base-load station of the Commonwealth Edison Company at Crawford Avenue, Chicago, it was found that there would be a definite gain in the use of steam at 550 lb. working pressure. To secure the full advantages of superheating at this pressure, it would have been necessary to go to approximately 1,000 deg. F. This temperature, of course, being beyond the limits of materials now available, 725 deg. F. was selected as the working temperature at the throttle, the deficiency in superheat to be compensated for by reheating the steam after it had passed through the primary element of the turbine, the temperature to be restored to approximately the initial conditions.

At the operating pressures and temperatures finally adopted for the Crawford Avenue plant, 550 lb. and 725 deg. F., reheating at 105 lb. gage to the initial temperature and exhausting to a vacuum of 29½ in., the theoretical economy of the reheating cycle, without any allowances for the boiler room, is 39.8 per cent. Theoretically, the heat saving due to reheating is only 2.8 per cent, but the actual gain probably will approximate 5 to 6 per cent, owing to improved economy from reduction of moisture in the steam in the lower stages of the turbine. To maintain this advantage, the unit must carry a uniformly high load and the drop in pressure through the reheater and the connecting piping must be held to a comparatively small figure, such as the limit set in the present case of 10 lb. Over moderate pressures and temperatures, say 275 lb., 565 deg. F. and 29-in. vacuum, on the straight Rankine cycle, the reheating plan indicates an improvement in fuel efficiency exceeding 15 per cent.

Stage bleeding at three points from the lower stages of the main turbines to heat the feed water, coupled with water economizers and a trial installation of air preheaters on one row of boilers, offered additional advantages which were not overlooked.

For the new plant a location on the west side was desired to balance the generating stations tied in on the 33,000-volt underground ring surrounding the city with a present capacity of close to 1,000,000 kw. The site on Thirty-fifth Street and Crawford Avenue is near the Chicago Belt line, so that rail facilities for coal are

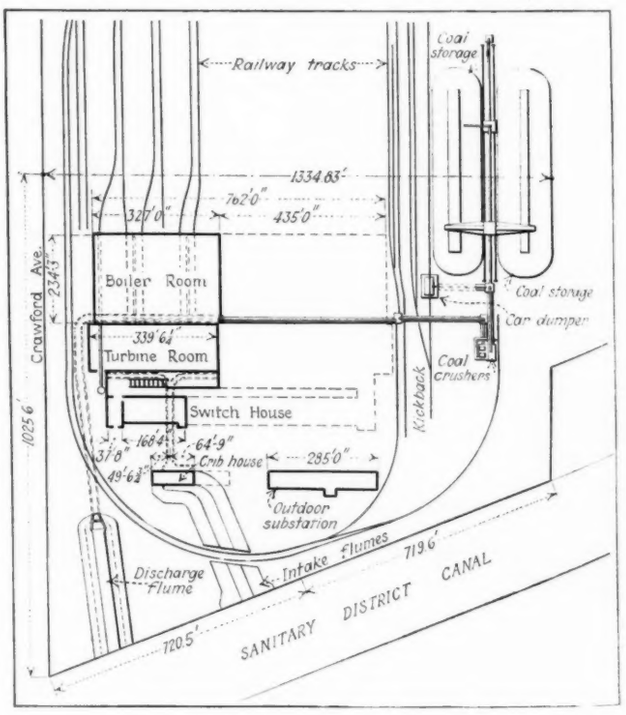


Fig. 1—Plot plan of property on which station is located

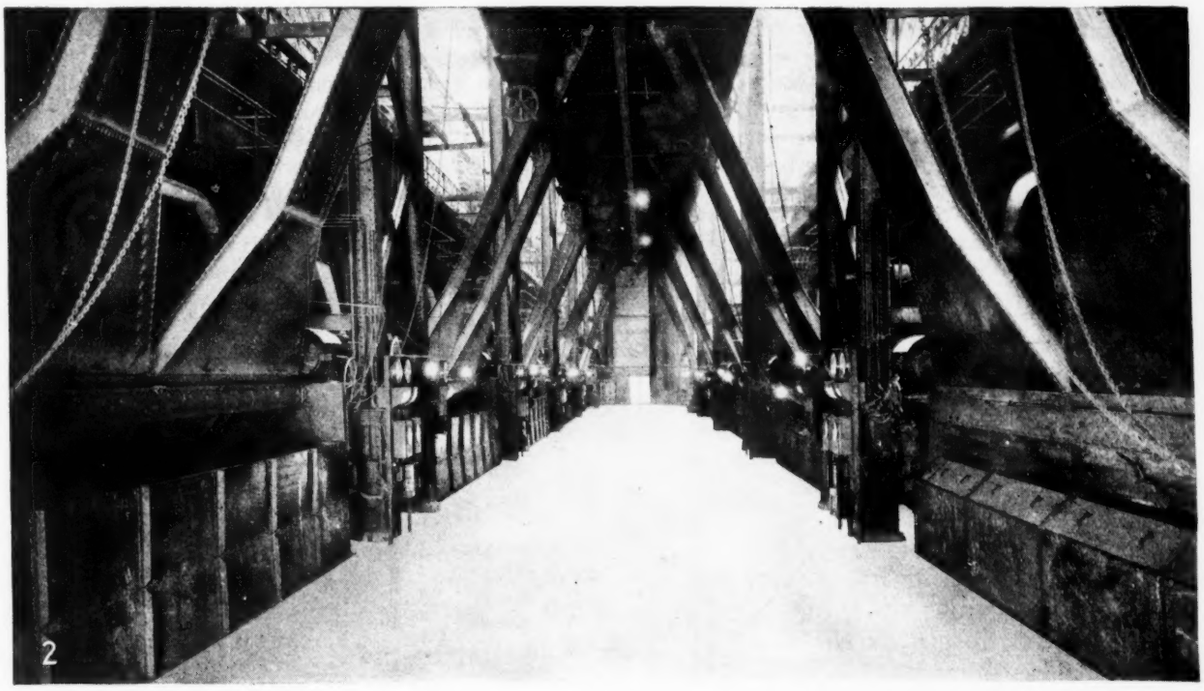
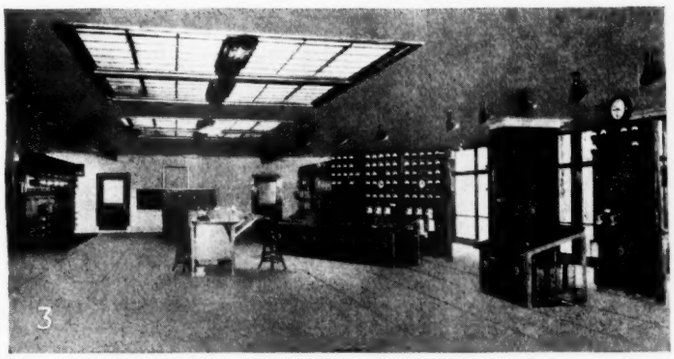
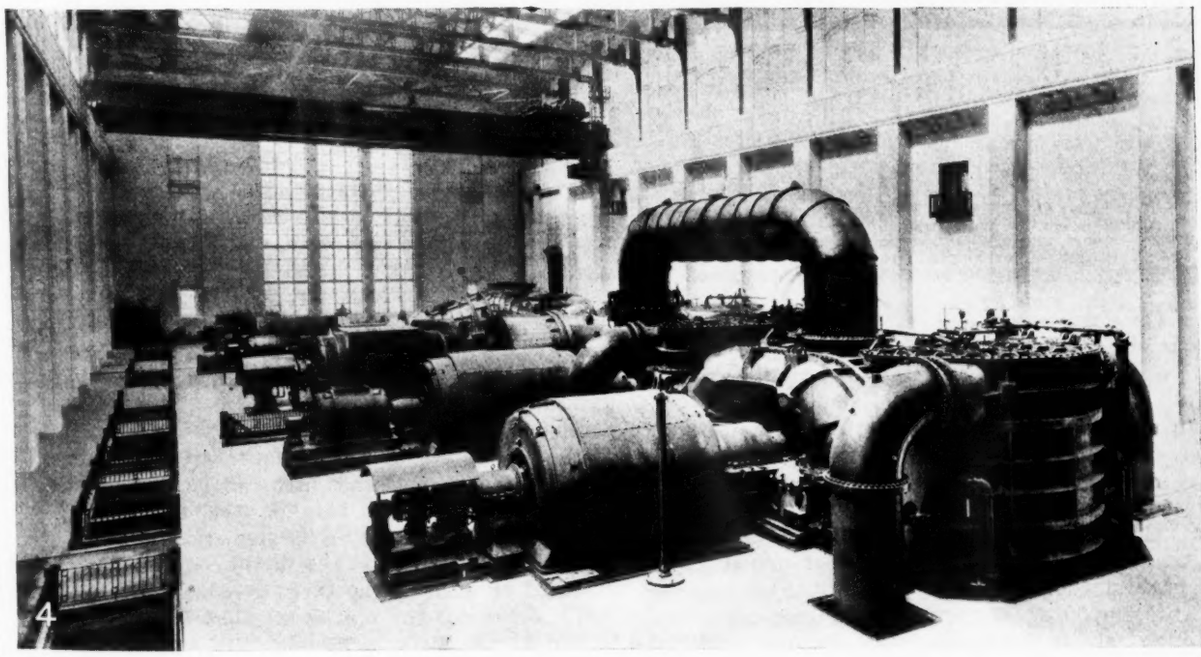


Fig. 2—Boilers are equipped with short stacks, induced- and forced-draft fans, and economizers. One row of five boilers are also equipped with air preheaters of the tubular type. Skylights provide good natural lighting in daytime to the firing aisles. Fig. 3—Operating gallery overlooking turbine room. Fig. 4—Each low-pressure turbine exhausts into two vertical condensers, one on each side of the turbine. The Westinghouse unit is in the foreground, with the General Electric and the Parsons units in the order named





good, and from the Drainage Canal plenty of water for all purposes is available, even if the flow is reduced to the much discussed minimum of 4,167 sec.ft. (see Fig. 1).

Present plans are for an ultimate plant of 750,000 kw. in eight to ten units. Space in the initial building has been provided for four units. Three have been installed, two of the machines having been in operation for some time and the third unit since May 24. For the first three units it was decided to divide the equipment among three representative firms in order to gain experience with different types of equipment under the unusual operating conditions to be encountered. To broaden the comparison, one of the main generating units was ordered from C. A. Parsons & Co., Ltd., and it will be of interest to add that its auxiliaries are practically all of English make. Rated at 50,000 kw., this unit, known as No. 1, consists of three separate turbines, all single flow—a 16,000-kw. 1,800-r.p.m. high-pressure turbine, a 28,000-kw. 1,800-r.p.m. intermediate machine and a 6,000-kw. 720-r.p.m. low-pressure element. The intermediate and low-pressure turbines are in tandem, giving the appearance of one machine with a generator on each end (see Fig. 5).

No. 2 is a 60-000-kw. General Electric cross-compound two-cylinder single-flow unit with impulse blading throughout. The high-pressure turbine drives a 17,000-kw. generator at 1,800 r.p.m., and the low-pressure turbine a 43,000-kw. alternator at 1,200 r.p.m. The third unit is a Westinghouse machine with high- and intermediate-pressure turbines on one shaft driving a 30,000-kw. generator and a double-flow low-pressure turbine driving a 20,000-kw. generator. The speed is 1,800 r.p.m. throughout. Except in the first two rows of blades, which are impulse, reaction blading is used. In the last two rows the Baumann divided exhaust has been adopted to shorten the low-pressure blading.

The fourth machine will be furnished by the General Electric Company and will be similar to No. 2 except that the capacity will be 75,000 kw. and the reheating will be eliminated, as it is believed that the first three units will handle the present 24-hour base load of this station. This addition will give an aggregate capacity of 235,000 kw. and complete the initial section of the plant.

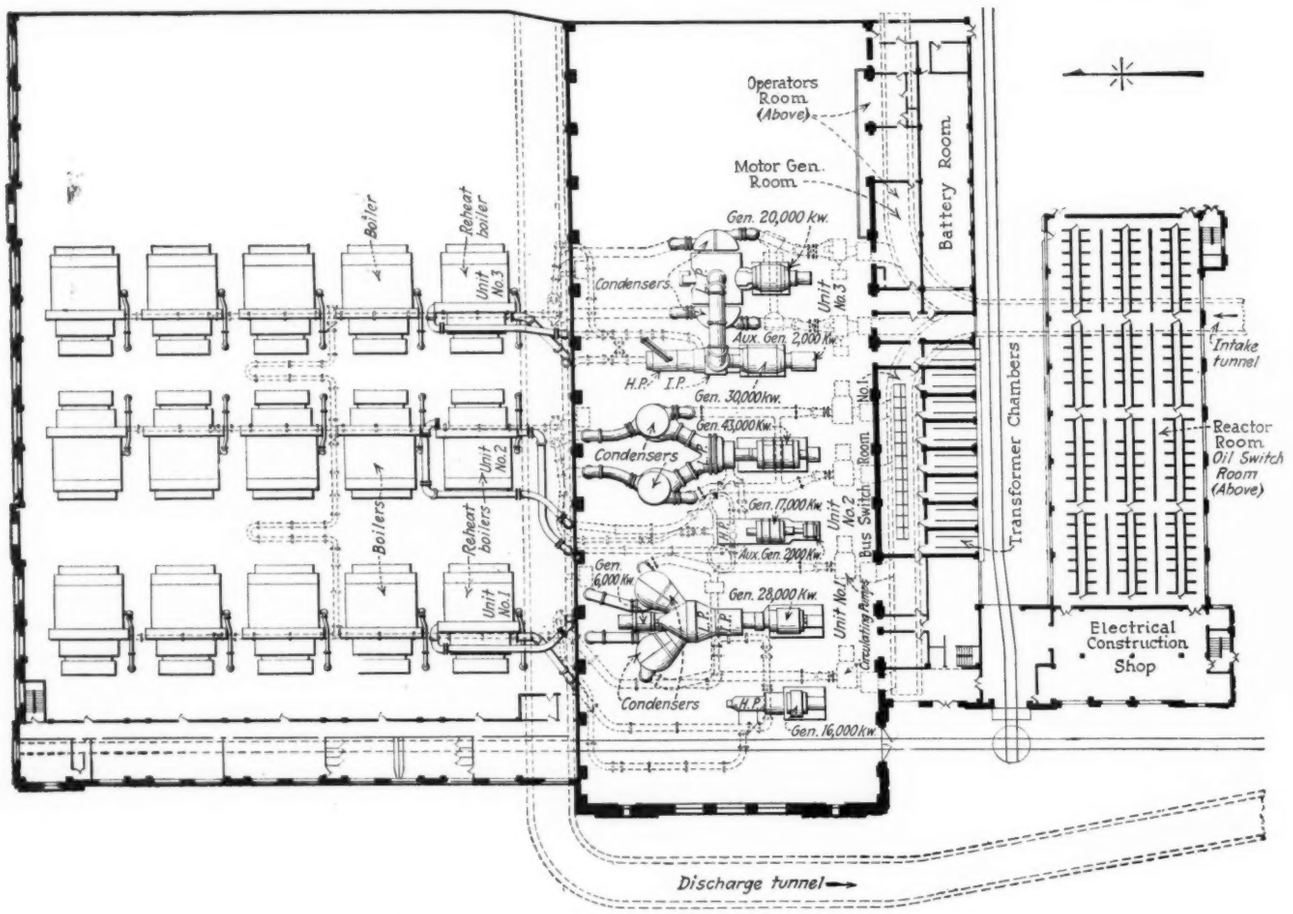


Fig. 5—Plan of station, showing general layout

Unit No. 1 is rated at 50,000-kw. and consists of three separate turbines, all single flow—a 16,000-kw. high-pressure, a 28,000-kw. intermediate-pressure and a 6,000-kw. low-pressure element. Unit No. 2 has a rating of 60,000-kw. in a high-pressure turbine of 17,000-kw. and a low-pressure turbine of 43,000-kw. capacity. Unit No. 3 comprises a high-pressure and intermediate-pressure turbine on the same shaft with an aggregate rating of 30,000 kw. and a low-pressure 20,000-kw. turbine, giving a total capacity of 50,000 kw. Each unit is served by five boilers, four normal and one reheat.

The generators of all the units are three-phase 60-cycle 12,000-volt machines. The alternators of a respective unit operate in parallel, the leads being tied together before they reach the station buses. For excitation of Unit No. 1 a direct-connected exciter is mounted on each of the three generator shafts. Auxiliary power for the unit is supplied by a transformer tapped to the main terminals. On each of the other two machines a 2,000-kw. auxiliary alternator supplies

the auxiliaries and one exciter provides excitation. Both are direct driven, the alternator by one element and the exciter by the other element of the unit.

In each of the three units now in place the steam is taken from the high-pressure turbine at a pressure approximating 105 lb. gage, reheated to 725 deg. F.[1] and returned to the intermediate or low-pressure turbine. By stage bleeding at three points in the Parsons unit, the temperature of the feed water is raised to 315 deg. F. upon entry into the economizer, and in the other two units three heaters are employed to give a feed-water temperature of 210 deg. into the economizer.

In each case the low-pressure turbine exhausts into two vertical condensers standing up adjacent to the machine, so that an efficient connection is obtained and basement height is conserved over the requirements of a horizontal condenser placed under the unit. Another factor having a bearing was that the large amount of sediment in the circulating water from the canal is less likely to foul vertical tubes.

As will be apparent from the plan view of the station, Fig. 5, the three units form practically three distinct plants, each being served by a row of five boilers and its complement of auxiliaries, although interconnection makes possible an interchange of steam between units. The boiler layout is practically identical. Four normal boilers and one reheat boiler make up the boiler unit, the reheat boiler in each case being nearest the turbine. There is some variation in the make of auxiliary equipment, but the layout and the sizes are practically the same.

As in the case of the main turbine units the stoker equipment was likewise divided among three different manufacturers. In each instance the main shaft of the stoker is driven by two adjustable-speed direct-current motors, one at each end of the shaft.

Boilers in adjacent rows face in opposing directions to form central firing aisles over which are the bunkers and below water-sealed ashpits with a traveling crane and grab bucket for transferring the ashes to railway cars entering the plant at grade. In the rear boiler aisles are the water economizers, and in row No. 1 air preheaters have the final opportunity to reduce the temperature of the flue gases. These preheaters are of the tubular type designed for a reduction in gas temperature approximating 120 deg. F. and a rise of 150 deg. F. in the air temperature, making possible a gain of about 3½ per cent.

Above the rear aisle are the induced-draft fans, one per boiler discharging directly upward into an over-roof breeching of increasing cross-section leading into a brick-lined steel stack supported on a structural-steel base and rising 150 ft. above the boiler-room floor. Except for the end row of boilers one stack of 30 ft. diameter, centrally located, will serve two rows, or ten boilers, four boilers discharging to the breeching on either side and the central boiler in each row into the base of the stack. A steel stack of 26 ft. diameter serves the first row of boilers.

Below the rear boiler aisles are the forced-draft fans, two per boiler, each discharging into a windbox on either side of the stoker, with cross connection between the two, so that operation at reduced capacity may be carried on with one fan. These fans draw their supply from the basement, no attempt being made to conserve radiated heat except in the case of the first row of boilers, where air heaters are installed and the air is drawn from over the boilers. The motors driving both the forced- and induced-draft fans are of the 2,300-volt slip-ring induction type, with 14 points of control giving a speed variation of 50 per cent. For the three fans of each unit the push-button control is centralized on the operating panel at the boiler front, the motor-operated controllers being near their respective motors. On the same panel are the flow meters, draft and pressure gages to give the necessary operating data to the fireman, and near-by is the hand-operated drum con-

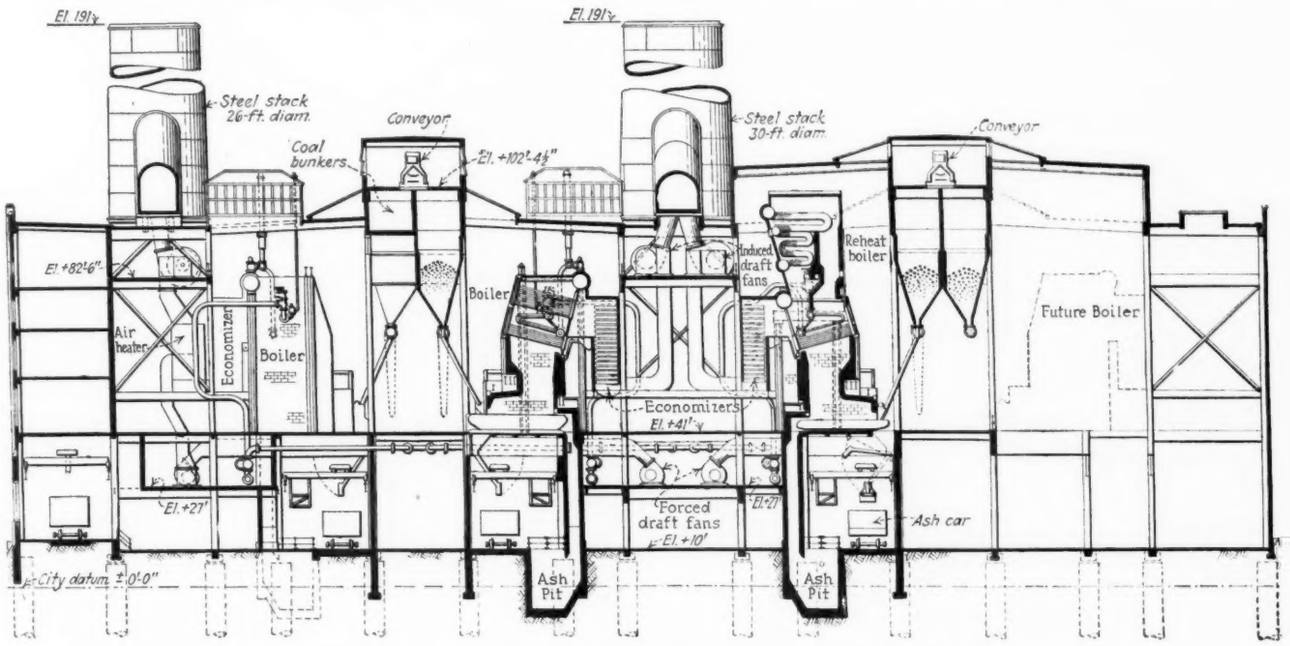


Fig. 6—Sectional elevations through boiler plant showing normal and reheat boilers

Boilers in adjacent rows face in opposing directions to form central firing aisles over which are the bunkers and below the water-sealed ashpits, with a traveling crane and grab bucket to transfer the ashes to railway cars entering the plant or grade.

[1] This is an average condition for the three units.

troller giving a range in speed for the stoker motors of from 400 to 1,600-r.p.m. The only variation from manual control is an automatic regulator to maintain a constant over-fire draft of about 0.2 in. by varying the position of the two dampers in the forced-draft supply in accordance with variation in the steam flow from the boilers. The dampers controlling the admission of air in opposing directions from the main supply duct on either side of the stoker are set to give the proper adjustment for the normal load. Any variation from this is adjusted for by the regulator control of the main supply.

An innovation is the introduction of fourteen openings across the width of the furnace, each of 12 sq.in. area, to supply from 12 to 15 per cent of the total air over the fire. The air is drawn from the main supply ducts by two motor-driven fans and forced through openings at the junction of the ignition and furnace arches, this having been found to be the best location for improving the secondary combustion. With the highly volatile coals of Illinois the experience had been that a great volume of green gases would come off at the front of the stoker. Forcing more air through the fuel bed to burn these gases only resulted in generating more gas, so that the logical thing to do was to supply the proper proportion of air above the fuel bed. The arrangement described has been effective in reducing the smoke.

Although some publicity has been given to the types of boilers employed in this station, it may be well to point out that the normal boiler is of the cross-drum double-deck type with a convection superheater between decks. In the lower deck there are eight rows of 3½-in. tubes and in the upper deck seventeen rows of 2-in. tubes, all being 15 ft. long. In the lower deck there is no baffling, so that the surface is exposed for the full length of the tubes to the radiant energy of the fire. A single baffle in the upper deck of tubes provides two passes from which the gases continue downward through a counter-current economizer at the rear.

A feature of the furnace is the great height of 25 ft. 6 in. from the floor to the bottom of the front tube header. The volume of the furnace in the various units ranges from 5,910 to 6,200 cu.ft. Other features to be noticed are the protection of the mud drum, the rear observation door and the high-pressure water-back connected into the boiler circulation with special refractory shapes in the vicinity, which are threaded to cast-iron hangers supported by steel girders. This provision was made to withstand the severe service at this point and to eliminate the spawling, cracking and falling out common with firebrick laid up in the usual way. For the balance of the setting the usual firebrick walls are employed with no special protection except that in two boilers in row No. 3 side-wall water screens are being given a trial. Plain tubes are employed of 3½ in. diameter spaced on 9-in. centers. The screens are connected into the circulating system of the boiler.

The reheat boiler is of the same general design as the normal boilers with the same furnace and stoker proportions. The steam-making surface, however, has been reduced to 6,007 sq.ft., and above this is the interstage superheater or reheater. The boiler portion will generate approximately 65 to 70 per cent as much steam as each of the normal boilers, but the primary object of the reheat boiler is to serve as a reheater for the steam returned from the turbine, the generating tubes being used solely to reduce the temperature of the furnace gases to something under 1,700 deg. F. before they come in contact with the superheater surface. The stoker will be operated to regulate the rise in temperature of the steam from the turbine, and the steam generated will be incidental. As a protection against emergencies motor-operated air doors are provided in the front of the setting for cooling the superheater.

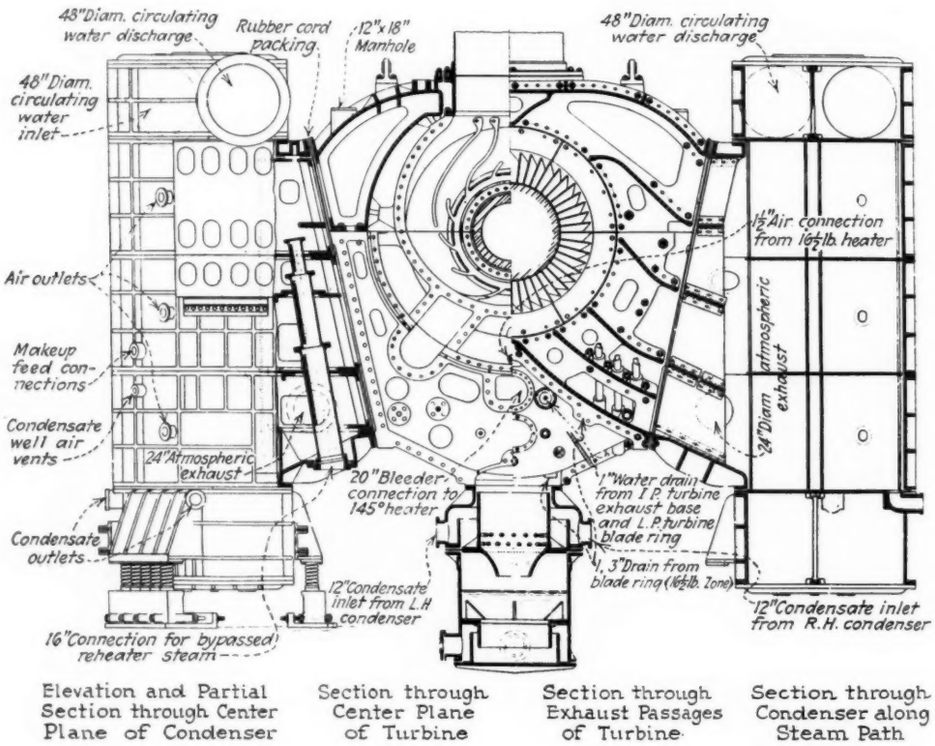

48"Diam. circulating water discharge
Rubber cord packing
12"x18" Manhole
48"Diam. circulating water discharge
48"Diam. circulating water inlet
Air outlets
Makeup feed connections
Condensate well air vents
24"Atmospheric exhaust
Condensate outlets
16"Connection for bypassed reheater steam
20"Bleeder connection to 145° heater
12"Condensate inlet from L.H condenser
1"Water drain from I.P. turbine exhaust base and L.P. turbine blade ring
1, 3"Drain from blade ring (16½lb. zone)
1½"Air connection from 16½lb. heater
24"Diam. atmospheric exhaust
12"Condensate inlet from R.H. condenser
Elevation and Partial Section through Center Plane of Condenser
Section through Center Plane of Turbine
Section through Exhaust Passages of Turbine
Section through Condenser along Steam Path

Fig. 7—Sections through condensers and intermediate- and low-pressure turbines of unit No. 3

Reaction blading has been used throughout the turbine, and in the last two rows of blades in the low-pressure turbine the Baumann divided exhaust arrangement has been adopted to shorten the low-pressure blading. In the exhaust passages continuous guide vanes from the turbine exhaust to the tube nests of the condensers, direct the steam in a stream-line flow to reduce eddy currents and lessen the pressure drop between the last blades and the condenser.

All high-pressure steam piping is of seamless tubing with Sargol joints. Steel valves with Monel trim designed for 900-lb. pressure are used, and the principal valves, such as the stop and check, the main header valves and the valves in the reheating lines are motor operated, with push-button control from operating panels near the valves and at other emergency stations.

Piping connections from the boilers in a row drop down through the floor into the header room to one long header increasing in diameter from 9 to 16 in., which is anchored to a steam separator at the large end. An expansion of 10 in. between hot and cold takes place toward the small end and away from the separator, varying the angle of the boiler leads from a slight inclination to one side, to the other side of the vertical, as they enter the header. From the separator a 16-in. line continues to the steam chest of the turbine. To obtain the proper degree of flexibility in steam piping between it and the turbine cylinder, four small pipes having generous loops are used in the case of Unit No. 3, instead of one for two large pipes. Nozzles at the entrance of these pipes increase the velocity of the steam and reduce the pressure, which is regained by means of diffusers as the steam enters the pressure nozzles of the turbine. A somewhat similar arrangement prevails on the other two units.

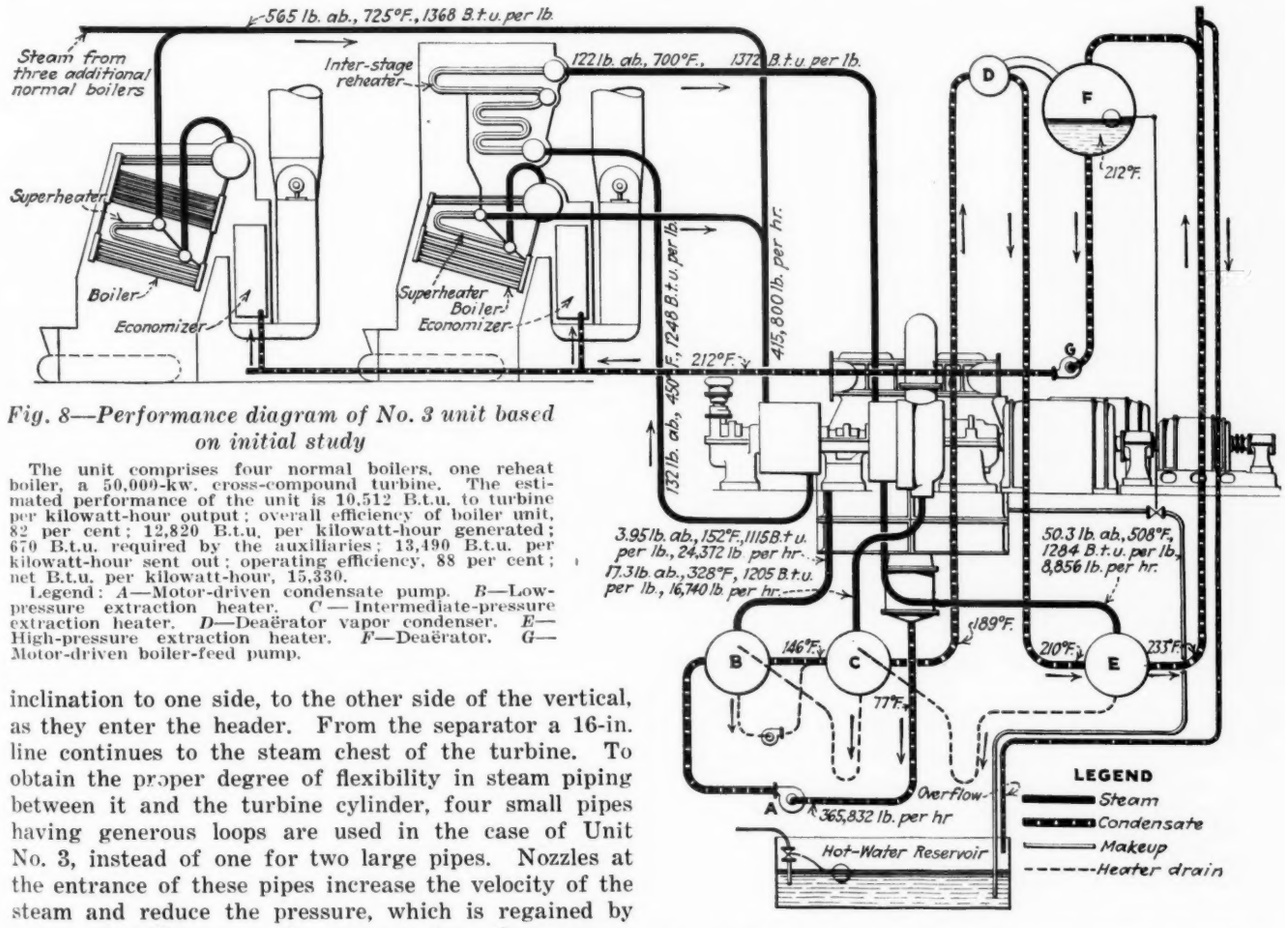


Fig. 8—Performance diagram of No. 3 unit based on initial study

The unit comprises four normal boilers, one reheat boiler, a 50,000-kw. cross-compound turbine. The estimated performance of the unit is 10,512 B.t.u. to turbine per kilowatt-hour output; overall efficiency of boiler unit, 82 per cent; 12,820 B.t.u. per kilowatt-hour generated; 670 B.t.u. required by the auxiliaries; 13,490 B.t.u. per kilowatt-hour sent out; operating efficiency, 88 per cent; net B.t.u. per kilowatt-hour, 15,330.

Legend: *A*—Motor-driven condensate pump. *B*—Low-pressure extraction heater. *C*—Intermediate-pressure extraction heater. *D*—Deaërator vapor condenser. *E*—High-pressure extraction heater. *F*—Deaërator. *G*—Motor-driven boiler-feed pump.

Previous publicity has been given in these columns to the General Electric and the Parsons turbines.[2] As previously stated, the Westinghouse unit comprises three turbines with the high- and intermediate-pressure turbines on one shaft and the low-pressure turbine as a separate element. Being designed for base-load service, the machine has but one governor valve, the point of highest efficiency being at the full load of 50,000 kw. To provide for short-period overloads and to take advantage of improved power factor, a hand-operated valve is supplied, which bypasses the nozzles and admits steam directly into the impulse chamber of the high-pressure turbine. The steam that passes through this valve is under governor control inasmuch as it is taken from the main steam pipe at a point between the governor valve and the turbine inlet. With this valve open, loads up to 64,500 kw. may be carried.

As a penalty of reheating there is a necessary complexity of governing apparatus. The quantity of steam in the reheater and its piping is sufficient to cause abnormal overspeeding should the turbine suddenly lose its load, so that means are provided to bypass this steam from the intermediate-pressure turbine. Any movement of the governor weights from their innermost position to that of mid-travel operates the governor valve, and when in the latter position the valve is closed. Farther onward movement of the weights simultaneously opens the bypass valve, bypassing the reheating steam to the condenser, and closes a butterfly valve in the inlet line to the intermediate turbine.

As the governor must have additional travel after the governor valve has closed in order to open the reheater bypass valve, collapsible and extensible links are provided. These links contain powerful springs, which, if required to be extended and compressed by the governor, would interfere with its speed characteristic; therefore, additional relays are provided between the governor and the relays of the valve mechanism. The additional relays require a greater rate of oil supply than the bearings if the valve is to respond quickly to speed changes, so an accumulator is installed which serves the double purpose of regulating the oil pressure in the governor system and supplies enough oil for one instantaneous complete swing of the valve gear without allowance for the quantity delivered by the oil pump.

In Unit No. 2 there is an intercepting valve between

[2]See *Power*, July 22, 1924, and Nov. 4, 1924.

the reheater and the low-pressure turbine, which, when tripped by the main turbine governor, shuts off the steam. There is also a relief valve on the exhaust from the high-pressure turbine, controlled by a Mercon regulator, which relieves to atmosphere in case the pressure builds up to a predetermined point. Additional protection is afforded by two 6-in. spring-loaded relief valves on the same line. No. 1 turbine also has the spring-loaded relief valves and the 12-in. Mercon control valve, and at the entrance to the low-pressure turbine a throttle valve controlled by the high-pressure governor.

As there would be serious objection to minor steam piping around the turbine carrying 550 lb. pressure, oil relays are used in connection with the automatic stop, automatic throttle and the control for the auxiliary oil pumps. The necessary oil pressure is obtained from pumps driven off the turbine shafts and stand-by steam pumps which are cut in automatically when the oil pressure drops below a given point.

In the low-pressure turbine of Unit No. 3 the double-flow principle, combined with multiple exhaust blading, has been adopted to enable the turbine to expand the steam efficiently to the high vacuum in the condenser and at the same time maintain the length of the blades within proper proportions for safe operating stresses. In the exhaust passages continuous guide vanes from the turbine exhaust to the tube nest of the condenser direct the steam in a stream-line flow to reduce eddy currents and lessen the pressure drop between the last blades and the condenser (see Fig. 7).

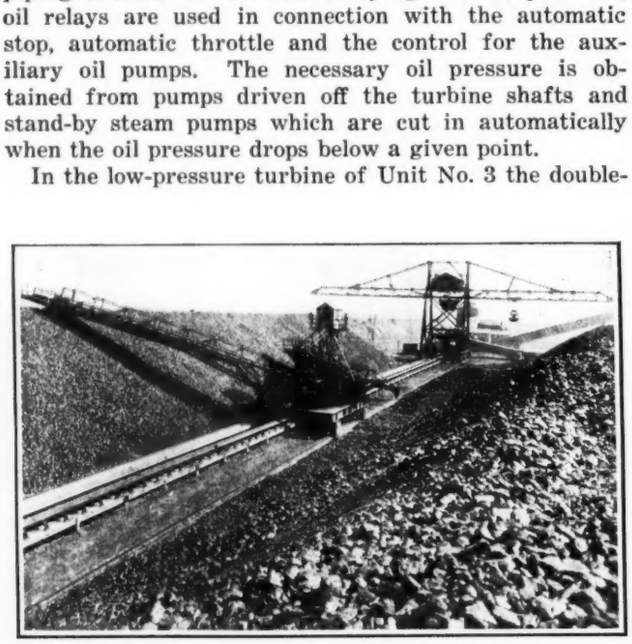


Fig. 9—Coal storage laid out for an ultimate capacity of 340,000 tons

A V-shaped shroud at the center of the condenser is provided to inclose the 16-in. connection for bypassing the reheater steam for the purpose of preventing local heating of the tubes by permitting distribution of the highly superheated steam over a large amount of surface.

A hotwell in the form of a jet condenser of rather large proportions is used to provide storage capacity in the event of tube failures. As there may be a depression in the temperature of the condensate, owing to the contact with the cold tubes and tube plates, the condensate is drained from the main condenser through nozzles spraying into the hotwell. As the water from the nozzles comes into intimate contact with steam from the main turbine exhaust, the condensate temperature approximates that of the steam at the inlet of the condenser, and by the same means the excess oxygen in the condensate is eliminated.

In Unit No. 2 the hotwell is in reality an open heater with trays for the condensate to flow over and mingle more intimately with the steam admitted from the steam space of the condenser. No. 1 Unit has the large hotwell, but no trays are provided.

Provision has been made for the extraction of steam from three pressure stages of No. 3 turbine, two bleeding points being located in the intermediate-pressure and one in the low-pressure turbine. When operating at full load, the bleeding pressures are approximately 4, 17 and 50 lb. absolute, all of which is shown in the performance diagram, Fig. 8, from which may be traced the paths of the steam, condensate, makeup and the heater drains.

From the hotwell of the condenser the condensate is pumped in series through the low-pressure and intermediate-pressure extraction heaters, *B* and *C*, the deaërator vapor condenser *D* and the high-pressure extraction heater *E* to the deaërator *F*, from which the boiler-feed pump passes the supply through the economizer to the boiler. Of the seven boiler-feed pumps provided for the three units, four are motor driven and three steam driven. The feed to the boilers is controlled by feedwater regulators and pump governors.

Inspection of the diagram will show that the admission of makeup to the system from the hot-water reservoir is controlled by a float in the deaërator *F*. This controls the position of a valve in the line between the reservoir and the condenser to which the makeup is drawn by the vacuum. Another float in the deaërator controls a valve in the condensate line, which, when the condensate has risen to a certain point in the deaërator, turns the flow back to the hot-water reservoir.

The flow diagram for Unit No. 2 is almost identical, but for Unit No. 1 there is some variation, as steam is bled from three different points, the highest being reheater steam at a pressure approximating 115 lb. absolute. A flow diagram for this unit appeared in *Power*, July 15, 1924.

Auxiliaries Used on Condensers

In connection with the two condensers of Unit No. 3, the following auxiliaries are used: Two motor-driven circulating pumps, one for each condenser; three motor-driven condensate pumps, one acting as a reserve to relieve either of the other two; one LeBlanc hydraulic pump, and as a stand-by one bank of steam ejectors consisting of two ejectors mounted on a common intermediate and after condenser. The air ejectors operate at 80 lb. gage pressure, the source of supply being the reheater pipe, and in case the reheater is not in service, steam from the main header is obtained and reduced to the required pressure by the use of several orifices.

In the other two units auxiliaries of much the same type are used, except that they are of different makes and there is no duplication of condensate pumps. The drives for the circulating and condensate pumps are slip-ring induction motors with a speed variation of about 25 per cent. With the circulating pumps it is possible to shut one down and let the other take care of the two condensers when water temperatures permit.

Two large intake tunnels opening from the bottom of the canal carry the station supply of water to the cribhouse, which is set back about 100 ft. from the bank of the canal. Although this water contains sewage and a great deal of sediment, it is circulated through

the condensers, but the makeup is purified for boiler use. The cribhouse has nine compartments, in six of which two traveling screens, one behind the other, have been installed, with the usual provisions for washing and bar-iron grills to keep out the coarser débris in the water. From the cribhouse a 12x12-ft. intake leads to the center of the turbine room with a branch either way to supply the respective units. On the other side of the turbine room is the discharge tunnel, which leads into an open flume discharging into the canal some distance downstream.

Makeup water for the boilers is taken from the intake tunnel, filtered through sand and gravel pressure-type filters and then passed through a Zeolite water-softening plant. In addition the water is given an acid treatment to increase the ratio of sulphates to carbonates in the boiler water. There seems to be a difference of opinion among engineers as to just what this ratio should be, but three to one is considered good practice. The softened water passes to the hot-water reservoir under float control, as indicated in the performance diagram, Fig. 8.

Kind of Coal Burned

Kincaid coal from Christian County, Ill., having on an average of 15 per cent moisture, 15 per cent ash, 4 per cent sulphur, and 10,000 B.t.u. per pound, is the fuel that is being used in the plant. To care for the initial installation an elaborate system of coal handling has been installed with provision for enlargement when extension makes this necessary. The present system is laid out to supply 400 tons per hour into the plant and 400 tons into storage, giving a maximum handling capacity of 800 tons an hour. The equipment consists of a car weigher and dumper, car puller, coal breakers, a traveling tripper and stacker for piling storage coal, a traveling gantry crane with grab bucket for reclaiming storage coal for use and the necessary conveyors between the various pieces of equipment mentioned (see Figs. 1 and 9).

Cars of incoming coal are pulled onto the car dumper, where they are weighed and emptied and the weight of the empty car is taken. As each car is pulled onto the dumper, it pushes the preceding car onto a gravity track with a kick-back and an automatic switch which shunts the empty cars onto storage tracks at a lower level for removal. From the hopper of the car dumper the coal is fed to a 48-in. belt conveyor leading to a junction house, where a bifurcated hopper discharges on one side to a belt leading to storage and on the other side to a belt traveling in the opposite direction to the breaker house. From the storage belt the coal is removed by a traveling tripper and stacker to the storage on either side, which has capacity when piled 40 ft. high for approximately 100,000 tons, although the ultimate storage for the complete plant will be 340,000 tons. The stacker consists of a boom with an endless belt which may be rotated to deliver to either pile.

Coal is reclaimed by a traveling tower with a grab bucket for transferring the coal to a hopper discharging onto the main belt conveyor, the direction of travel having been reversed, so that delivery is made to the belt conveyor leading to the breaker house. Here are located two rotary breakers, each of 250 tons per hour capacity, which operate singly or in parallel and deliver the broken coal onto a belt conveyor leading to a second junction house. Provision is made for crushing oversize coal rejected from the breakers and delivering it to this belt conveyor, or the refuse may be conveyed to a dump on the premises.

At the junction a right-angle turn is made, and on an inclined conveyor the coal passes to a third junction house part way up the incline. From this point it is elevated to a height corresponding to the top of the bunkers and is carried horizontally on another belt conveyor running the full length of the boiler house and delivering to cross conveyors supplying the bunkers on either side of the central firing aisles. The final junction house is beyond the limits of the ultimate plant, so that the coal-handling system will fit in with future plant extension. The main belts employed are 36 in. wide, but run over 48-in. idlers, so that the capacity can be increased whenever desirable. All the coal-handling equipment is motor driven with special control stations at convenient points.

Electrical Equipment

To house the electrical equipment of the plant, transformer and switchhouses have been built along the length of the turbine room. The switchhouse was constructed on the isolated-phase plan adopted by the company first at Calumet Station, with the exception that there are two walls for each phase, with a working space between in which are carried the operating rods, ground connections and vent pipes for the oil pots. The phases are on 21-ft. centers with fireproof barrier walls between. There are two main buses, in accordance with company practice, and eight line buses with the necessary switching equipment for twenty-four 12,000-volt lines and five feeders to an outdoor substation where the voltage is stepped up to 33,000 for underground trunk tie lines to the other stations of the system. The switching equipment is hydraulically operated. Reactors are placed in all generator leads and in all outgoing lines, including the services to the outdoor substation and to the 12,000-volt auxiliary power bus.

Normally, the station auxiliaries receive their energy from the auxiliary generators driven by the main units; that is, units Nos. 2 and 3 have direct-connected auxiliary generators and unit No. 1 a transformer tapped to the main terminals of the machine. All essential auxiliaries for each unit, including the boiler draft fans, are supplied in this way independently of the station buses, thus eliminating any trouble that might develop from the line. For starting, energy is supplied from a 2,300-volt transfer bus common to all machines, connected through 12,000- to 2,300-volt transformers to the 12,000-volt auxiliary power bus, which may be connected to either one of the main station buses. When the main unit and the direct-connected auxiliary generator is up to speed, the latter is paralleled with the transfer bus and the auxiliary load taken over independently of the system.

On the fourth floor of the transformer house overlooking the turbine room is the operating gallery, at the temporary end of the present building, approximately the center of the ultimate plant. Here are the benchboards and instrument panels for the main generators, the control panels for outgoing lines and the services to the outdoor substation and auxiliary equipment.

Sargent & Lundy, Inc., were the consulting engineers on the design and construction of the steam end of the plant. The electrical design is to be credited to the engineering department of the Commonwealth Edison Co. Graham, Anderson, Probst & White were employed for the architectural design.

PRINCIPAL MECHANICAL EQUIPMENT IN THE CRAWFORD AVENUE STATION

GENERAL

Capacity, installed, kw	160,000
Capacity, ultimate, kw	750,000
Consulting engineers	Sargent & Lundy, Inc.
Present building, general contractor	G. A. Fuller Company
Ground area per kw:	
Boiler room, sq.ft	0.33
Turbine room, sq.ft	0.18
Switch and trans. hse., sq.ft	0.12
Total, sq.ft	0.63
Volume per kw:	
Boiler room, cu.ft	31.7
Turbine room, cu.ft	19.2
Switch and trans. hse., cu.ft	5.7
Miscellaneous, cu.ft	1.3
Total, cu.ft	57.9
Avail. for future, cu.ft	3.1
Net volume per kw., cu.ft	54.8

NORMAL BOILERS, SUPERHEATERS AND ECONOMIZERS

Make	Babcock & Wilcox Co.
Type of boilers	Steel-cased, cross-drum
Number installed	12
Water heating surface, ea., sq.ft	16,615
Superheater surface, sq.ft	2,700
Economizer surface, sq.ft	11,054
Diam. of tubes	Lower deck, 3½ in., upper deck, 2 in.
Drum	Diam., 48 in.; length, 31 ft. 8 in.; plate thickness, 1 13/32 in.
Boiler surface installed per kw., sq.ft.	1.35
Ratio superheater area to boiler surface	1 to 6.15
Ratio economizer area to boiler surface	1 to 1.495
Boiler pressure, lb. gage	600
Steam temperature, deg. F	750
Air heaters	2 B. & W. Co.; 3 Buffalo Forge Co.
Type	Tubular
Surface each approx., sq.ft.	10,000
Soot blowers, 29 per boiler	Diamond Power Specialty Corp.

REHEAT BOILERS

Make	Babcock & Wilcox Co.
Number	3
Water heating surface	Units 1 and 3, 6,007 sq.ft.; unit 2, 5,509 sq.ft.
Superheating surface, sq.ft	1,700
Reheating surface, sq.ft	14,000

FURNACES

Type of boiler setting	Brick steel-encased, Bishop Contracting Co.
Suspended arches	10 Liptak; 5 Detrick
Insulating brick—nonpariel	Armstrong, Cork & Insulation Co.
Furnace casing	Sheet steel
Furnace volume per 10 sq.ft. of water heating surface, cu.ft	3.73 to 3.56

STOKERS

No. per boiler	1
Type	Forced draft, chain grate
Width, ft	24
Make—5 Babcock & Wilcox—effective area, sq.ft	444
—5 Coxe—effective area, sq.ft.	423
—5 Illinois—effective area, sq.ft	423
Drive	D.C. motors, variable speed
Fuel	Christian County, Ill., coal
B.t.u. per lb. approx	10,000

DRAFT APPARATUS

Forced draft fans, 30	Buffalo Forge Co.
Capacity each, c.f.m.	40,000
Aux. forced draft fans, 30	B. F. Sturtevant Co.
Capacity each, c.f.m.	5,500
Induced draft fans	10 B. F. Sturtevant; 5 Green Fuel Economizer Co.
Capacity, each, c.f.m	115,000
Stoker damper control	The Hagan Corp.

STACKS

Type	Steel, brick lined
Number	2
Height above boiler room floor, ft.	150
Diameter	One, 30 ft.; one, 26 ft.

COAL HANDLING

Car dumper	Wellman, Seaver, Morgan Co.
Capacity	Twenty 120 ton cars per hour
Breakers, 2 Bradford, capacity each, tons per hr.	250
Coal carried either to storage or bunkers by	36 in. belt
Conveyors, capacity either way, tons per hr.	400
Coal stored by means of traveling stacker and reclaimed by	Traveling tower with grab bucket
Entire equipment furnished by	The Koppers Co.
Track scale	Fairbanks, Morse & Co.
Storage capacity	Present 100,000 tons, approximately; ultimate, 340,000 tons
Car puller, one	Whiting Corp.

TURBO-GENERATORS

Make	Unit No. 1 C. A. Parsons Co., Ltd.	Unit No. 2 Gen. Elec. Co.	Unit No. 3 West. Elec. & Mfg. Co.
Cap. h.p. sec., kw	16,000	17,000	30,000
Cap. i.p. sec., kw	28,000		
Cap. l.p. sec., kw	6,000	43,000	25,000
Steam press. at throttle, lb.	550	550	550
Steam temp. at throttle, deg. F	725	725	725
Steam press. at reheat, lb. abs	115	120	132.5
Steam temp. before reheat, deg. F	430	412	...
Steam temp. after reheat, deg. F	700	725	700
Exhaust pressure, in. hg. abs	1	1	1
Speed h.p. sec., r.p.m.	1,800	1,800	1,800
Speed i.p. sec., r.p.m.	1,800	...	...
Speed, l.p. sec., r.p.m.	720	1,200	1,800
Gen. air cooler type	Surface	Fin. surface	Surface
Aux. generator, kw	...	2,000	2,000

CONDENSERS

Make	C. A. Parsons & Co., Ltd.	Worthington	Westinghouse
Type	Vertical Surface	Vertical Surface	Vertical Surface
Number	2	2	2
Surface, total, sq.ft	56,000	75,000	65,000
Surface per kw., sq.ft.	1.12	1.25	1.30
Tube, outside diameter, in.	1	1	1
All tubes made by	British Amer. Metals Co.		

CIRCULATING PUMPS

Make	Worthington	Worthington	Westinghouse
Number	2	2	2
Drive	Motor	Motor	Motor
Capacity each, g.p.m.	40,000	40,000	35,000
Capacity per kw., g.p.m.	1.60	1.335	1.40

CONDENSATE PUMPS

Make	G. & J. Weir	Worthington	Westinghouse
Number	2	2	3
Capacity, g.p.m.	1,000	1,200	950
Drive	Motor	1 motor; 1 turbine	Motor

BOOSTER PUMPS

Make	G. & J. Weir		
Number	2	.....	.....
Stages	One	....	....
Capacity, lb. per hour from 25 to 200 lb.	450,000	....	....
Drive	Steam turbine	....	....

AIR PUMPS

Type	3-Stage Steam Ejectors	Hydraulic, Vacuum	LeBlanc Air Pump
Number	2 sets	4 Also 4 steam jet two stage ejectors	1 One bank steam jet ejectors

BOILER FEED PUMPS

Make	G. & J. Weir	A. S. Cameron	A. S. Cameron
Number	2	1	1
Stages	1	4	4
Capacity, g.p.m.	1,000	900	900
Speed, r.p.m.	3,540	3,450	3,450
Drive	Motor	Motor	Motor
Make	Bethlehem Shipbldg. Corp.	Bethlehem Shipbldg. Corp.	Bethlehem Shipbldg. Corp.
Number	1	1	1
Stages	1	1	1
Capacity, g.p.m.	900	900	900
Drive	Turbine	Turbine	Turbine

FEED WATER HEATERS

Make	Bethlehem Shipbldg. Corp.	The Elliott Co.	The Elliott Co.
Number	6 closed heaters	Deaerator and 3 closed heaters	Deaerator and 4 closed heaters

VALVES AND PIPING

Stop and check valves	Edward Valve & Mfg. Co.
Globe valves	Edward Valve & Mfg. Co.
Gate valves	Crane Co.
Automatic relief valves	D. H. Skeen & Co.
12-in. sectionalizing, 16-in. main steam and reheat valves, motor operated	
Motor control on 10 nonreturn valves	Chapman Valve Mfg. Co.
Motor control on 5 nonreturn valves	Payne Dean
Blowoff valves	Edward Valve & Mfg. Co.
Safety valves	Manning, Maxwell & Moore, Inc.
Motor operated sluice gate valves	The Ludlow Valve Mfg. Co.
Steam separators	M. W. Kellogg Co.
Steam traps	Crane Co. The C. E. Squires Co.
High press. steam piping furnished by	Crane Co.; erected by W. A. Pope
Pipe covering and insulation	Johns Manville, Inc.
Circulating water piping	M. W. Kellogg Co.

MISCELLANEOUS

Cranes, two 125-ton	The Whiting Corp.
Cranes, ash handling, three 2 cu.yd.	The Whiting Corp.
Traveling screens, 12	Link Belt Co.
Feed water regulators, 15 Mercon, 4-in.	D. H. Skeen & Co.
Feed water regulators, 10 S-C, 4 in.	The S-C Regulator Co.
Feed water regulators, 5 Copes special, 4 in.	Northern Equipment Co.
Fin. type surface air coolers, two	General Electric Co.
Tubular air coolers, two	Westinghouse Elec. & Mfg. Co.
Strainer units, two	E. B. Badger & Sons Co.
Metering equipment	Bailey Meter Co.
Coal valves and spouts, 30	Henry Pratt & Co.
Smoke flues	Henry Pratt & Co.
Fan ducts	The Sykes Co.

Parallel Operation of D.-C. Generators—Compound-Wound Type

Characteristics of Machines for Successful Parallel Operation—Adjustment of Voltage—Division of Load Between the Machines—Effects of Changing the Resistance of Series-Field Shunt

By C. LYNN

TO OPERATE machines successfully in parallel whether they be electrical or mechanical, they must have similar characteristics, so that they will divide the total load proportional to their respective ratings. Furthermore, it is necessary that each machine tend to shirk its share of the load. If the tendency were otherwise, one machine would start taking more than its proportionate share of the total load. Having taken more load, the machine would tend to take still more load, until it would be carrying the total. The machine hogging the load might drive the other machines operating in parallel with it if it were within its capacity to do so. If a machine does not have an inherent drooping load characteristic, it is necessary to modify it so that it does, as in the case of an equalizer connection when paralleling overcompounded direct-current generators.

Two Requisites for Parallel Operation

The two requisites for successful parallel operation of direct-current generators are:

1. The generators must have approximately the same compounding or voltage regulation from no load to full load.
2. The voltage drop through the series fields and leads to the switchboard must be the same in all generators at full load.

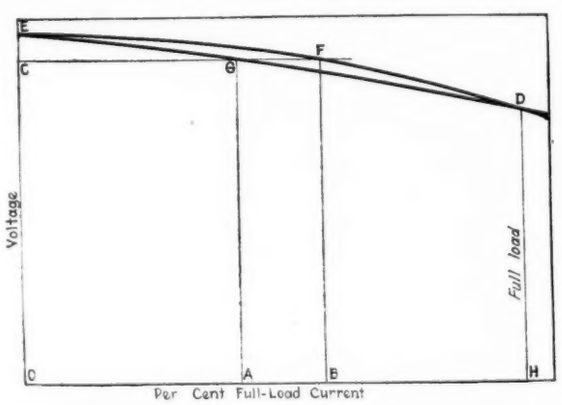


Fig. 1—Showing the division of load between two generators, with different regulation curves operating in parallel

The voltage regulation must be taken at the points where the generators are paralleled—that is, at the switchboard—so as to include the voltage drop in the leads and must be taken with the equalizer switch open. This voltage regulation includes the variations, if any, due to the speed regulation of the generator's prime mover. The voltage regulation can be varied by changing the governor setting, in the case of an engine-driven generator, by adjusting the shunt across the series field or by a slight shifting of the brushes in the case of a commutating-pole generator. Shifting the brushes against the direction of rotation increases the compounding, and shifting with rotation decreases the compounding. This latter method must be done with caution, since shifting the brushes will cause sparking if they are shifted too far.

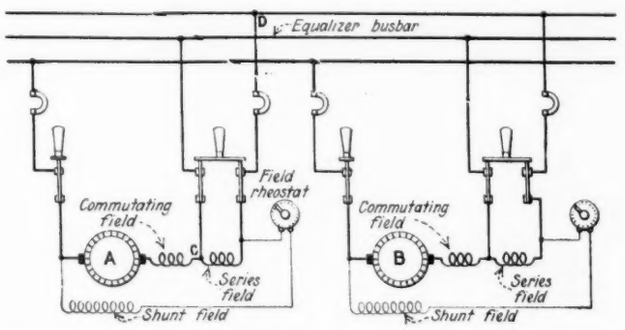


Fig. 2—Diagram of two generators connected in parallel

The effect of the difference in the inherent shapes of the regulation curves of two generators is to cause an unequal division of the total load current. For example, if two generators have the same no-load voltages and the same full-load voltages, but one has an almost straight voltage-regulation curve, while the other one has a hump in its curve, the one with the hump will take more than its proportional share of the total current when the load on it is at the points corresponding to the hump in the regulation curve. In the average installation this unequal division of load between two generators is not objectionable, since it almost always occurs when the generators are each carrying less than full load.

Division of Load on Generators

The foregoing can be understood by referring to Fig. 1, where *EFD* is the voltage regulation curve of one of two direct-current generators operating in parallel. This curve has a pronounced hump. Curve *EGD* is that of the other generator. Since these two generators are in parallel, their voltages at any given instant or with any given total load upon them are exactly the same. Therefore, to find the load that each generator is carrying at any voltage such as *OC*, draw through *C* a line such as *CGF* parallel to *OH*. This line intersects curve *EDF* at *F* and *EGD* at *G*, then *CF* or *OB* is the load current carried by the first generator and *CG* or *OA* is

the load current carried by the second generator. At the full-load current values, *OH*, the voltages of the two generators are the same. The same thing, except at a different voltage, occurs at no load. Thus these two generators divide the loads equally at no load and full load, but between these two points the generator with the highest voltage curve takes more than its proportional share of the total current.

Ordinarily, this unequal division of current is not objectionable. Where the hump is very pronounced, it may be advisable to lower the voltage regulation curve of this generator so that it crosses the voltage regulation curve of the other machine at about one-quarter load and three-quarters load instead of no load and full load. This will give a less total variation of the current division between the two generators. The only way that the hump of the voltage regulation curve can be made less pronounced is by a change of the design of the generator. If the prime mover has a speed regulation curve with a hump in it, it will cause the generator to have a still greater hump in its voltage regulation curve.

Division of Currents in Series Fields

Since the series-field circuits of direct-current generators are resistance circuits, the currents in them when they are connected in parallel by the use of equalizer connections, are inversely proportional to their respective resistances. It is thus necessary that the resistance of each series-field circuit be such that with rated current the voltage drop is the same through each. If this is otherwise, more than a proportional share of current will flow in the series field of the machine whose series-field circuit resistance is too low. This will cause more than the machine's share of current to flow in its series-field windings and overcompound this generator. The other generator, having too little current in its series field coils, will tend to shirk the load, thus causing unequal division of load between the machines.

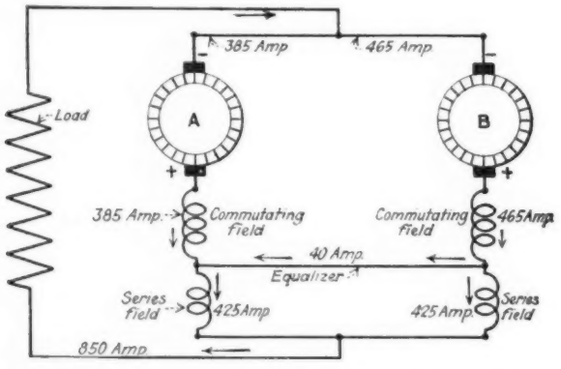


Fig. 3—Simplified diagram of Fig. 2 showing the division of the load

If the resistance of the series-field circuit of machine *A*, measured from the equalizer connection on the machine at *C*, Fig. 2, to where the main lead from the series field connects to the busbar of the switchboard at *D* is too low, an additional resistance, large enough in capacity to carry the total load current of the generator, must be inserted in this circuit, so as to make the *IR* drop equal to that of the same circuit on machine *B*. This resistance, which generally has to be of a low value, may be made of lengths of cable of the same size as the leads of the machine, coiled up and placed behind the switchboard or some other out-of-the-way place. If it happens that a relatively high value of resistance is required, it may be made up of grid resistors.

Since the series-field resistance of high speed generators is nearly always less than that of the same capacity slow-speed generators, the former almost always require extra resistance in their series-field circuits when they are paralleled with slow-speed machines. Exceptions to this would be when the leads of the high-speed generators happen to be considerably longer than those of the low-speed machines.

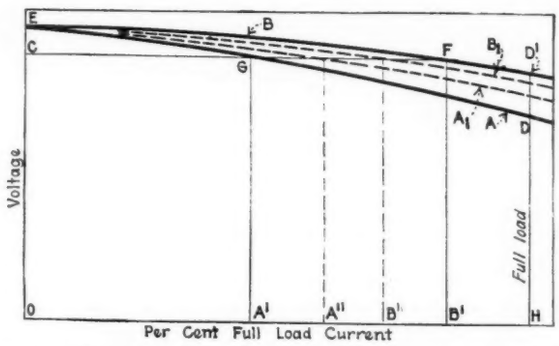


Fig. 4—Showing how the division of the load affects the regulation curves of two generators operating in parallel

If the series-field *IR* drops of two machines in parallel are alike at full load, but their regulations are unlike, the generator with the higher regulation curve will take more than its proportional share of the total current, even though the division of total current through the series fields of the generators is proportional to the ratings of the generators.

Use of Equalizer Connections

Fig. 3 shows a schematic connection diagram of the two generators *A* and *B* in parallel, Fig. 2, which for convenience are considered to be of the same capacity. It will be noticed that the inner ends of the series fields are connected together by a connection called the equalizer. This connection together with the connection joining together the outer ends of the series fields, puts the two series fields in parallel, thus causing them to divide the total load current inversely proportional to their respective resistances. It is therefore necessary that the equalizer connection be of low resistance, and it is generally made the same size as the main leads from the generators.

Curve *EGD*, Fig. 4, represents the regulation curve of generator *A* when operating alone, and curve *EFD'* represents the regulation curve of generator *B*. Operating alone at a voltage *OC*, generator *A* would carry a current of *OA'*, while generator *B*, operating alone at the same voltage, would carry a load current of *OB'*. This is on the assumption that both generators have a no-load voltage *OE* and that a load *OA'* is put on generator *A*, after which generator *B* is loaded until its voltage drops to equal that of machine *A*. For example, assume that a load of 300 amperes is put on machine *A* and the voltage drops from 225 to 215. Machine *B* is now loaded until its voltage drops from 225 to 215 and it is found that the load is 550 amperes.

If the two generators, while operating under the

conditions cited, were paralleled, as shown in Fig. 3, one-half of the total current, that is (300 + 550) ÷ 2 = 425 amperes, would flow through the series field of each generator. This would cause the compounding of generator *B* to be reduced, as less current would be flowing through its series field, and conversely the compounding of generator *A* would be increased. The regulation curves of the generators would then be somewhat as indicated at A_1 and B_1, Fig. 4, instead of *A* and *B*,

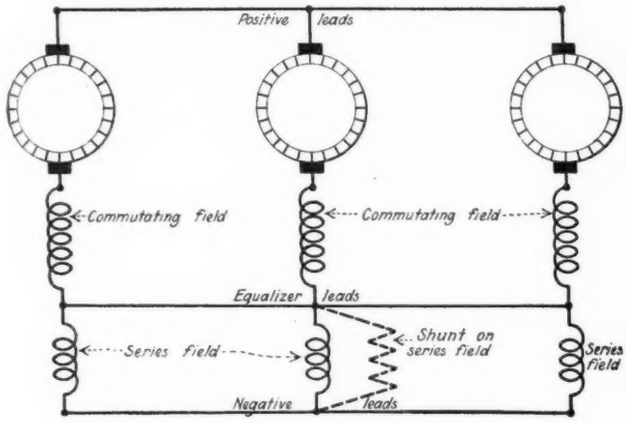


Fig. 5—Simplified diagram of three generators connected in parallel

and the currents carried by the generators would be *OA″* and *OB″* respectively. In this case assume that, owing to the change in compounding of the machines, 85 amperes of the load on machine *B* is shifted to machine *A*, which would give a load distribution as in Fig. 3. Since generator *B* is carrying more than its share of the total current and this current divides equally between the series fields, the difference between the current in the armature and series field of generator *B* will flow through the equalizer and into the series field of generator *A*. The distribution of the current in the different circuits is shown in the figure.

Effect of Shunt on Series Field

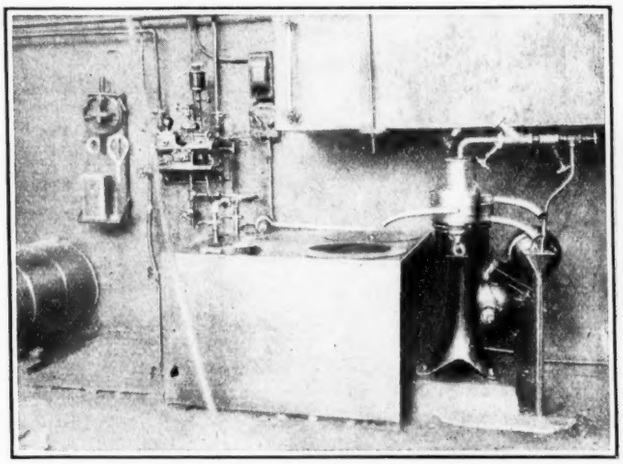
In order to cause the two generators, Fig. 3, to take the same current at any load, it will be necessary to make the regulation curves of the two machines alike. If they differ but slightly, this can be done by shifting the brushes (assuming commutating-pole generators) as previously explained. In case this is not desirable and a shunt is connected across the series field of generator *A*, increasing the resistance of this shunt will tend to cause this machine to take more load. Reducing the resistance of the shunt, if there is one across the series field of generator *B*, will cause this machine to take less of the total load. In this connection it should be noted that changing the voltage regulation by changing the resistance of the shunt across the series field, changes the resistance of the series-field circuit of the generator. In exceptional cases it may be necessary to adjust the series-field-circuit resistance after the resistance of the shunts across the series-field coils has been changed. This is done by slightly increasing the resistance of the lead between the series field terminal and the switchboard when the resistance of the shunt has been reduced. On the machine that has had the resistance of its series-field shunt increased, the series-field lead resistance is reduced by connecting additional cables in parallel with this lead. This will, if properly done, keep the series-field circuit resistance unchanged.

In case the adjustment, referred to in the foregoing, is not made, it will be seen by reference to Fig. 5 that a shunt on the series field of any of several generators in parallel acts as a partial shunt on the series fields of all the generators, since the series fields are all in parallel between the negative and equalizer leads.

Any kind of apparatus to be paralleled must have drooping load characteristics. If such is not the case, as in flat- or overcompounded direct-current generators, then a means must be provided such as the use of an equalizer, to keep one machine from taking all the load. Another way of looking at this is to consider the machines as paralleled inside the series fields at the equalizer connections. As such they may be considered as shunt machines and have drooping load characteristics. The more drooping the load characteristic the better will the machine divide the load. This is the reason shunt-wound generators divide the load more satisfactorily when operating in parallel, than do compound-wound generators. Thus, whenever possible, it is better to have the compounding slightly drooping, in so far as ease of paralleling is concerned. However, most generators are operated either flat compounded or overcompounded, so it is necessary that the adjustments of the generators and leads be correct in order to secure successful parallel operation.

Lubricating-Oil Filtration System

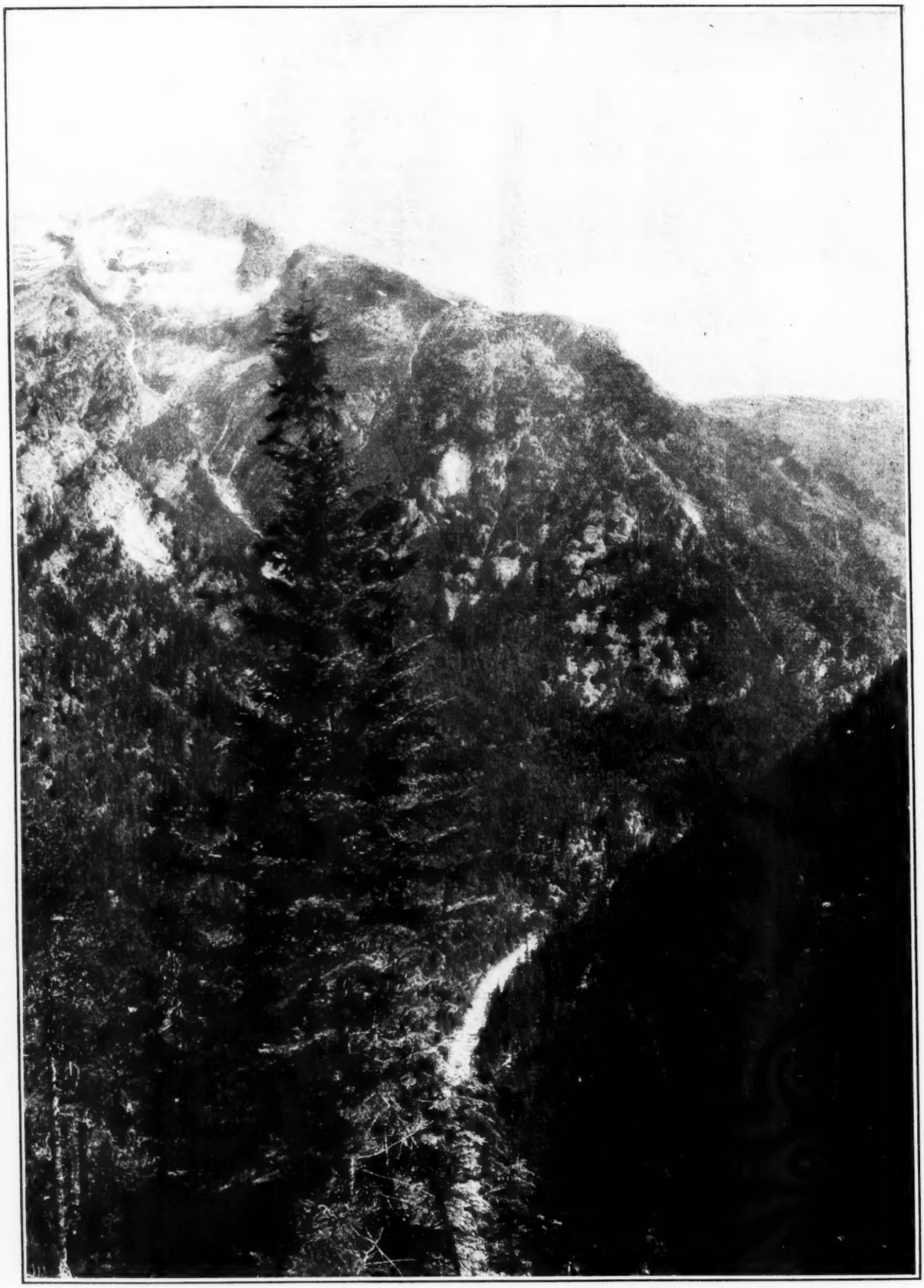
In the illustration is shown a neat arrangement of lubricating-oil tanks and centrifugal filter in the basement of a municipal water works. The oil from several vertical triple compressed pumping engines drains into



Oil filtration system

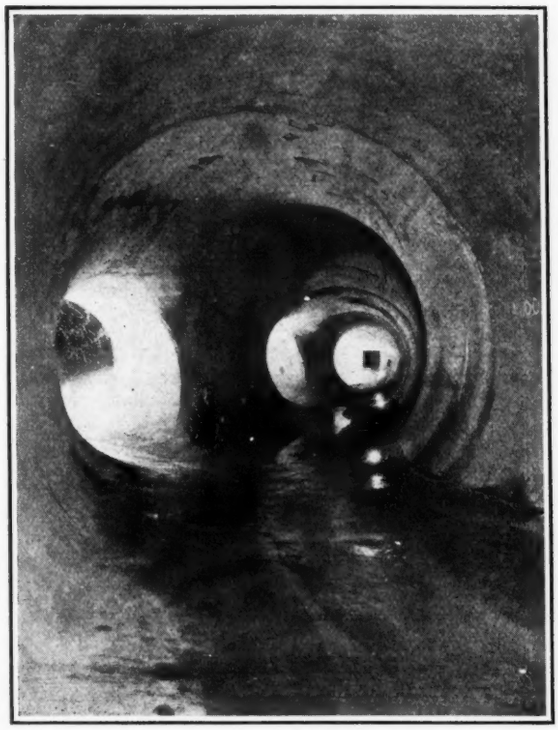
the tank shown above the centrifugal. It is then fed into the bowl of the filter and the water and solid material are thrown out of the oil and, passing through the two funnels to the right, drain into the sewer.

The clean oil issues out of the left funnel and drops into the storage tank. A simplex steam pump mounted on a wall bracket is used to raise the oil out of the tank and deliver it to the gravity head tank located above the engines and other machinery. From this head tank piping leads the oil to the engines and to a number of oil stands close to the machines. While the filter equipment occupies a small space, each part is accessible.

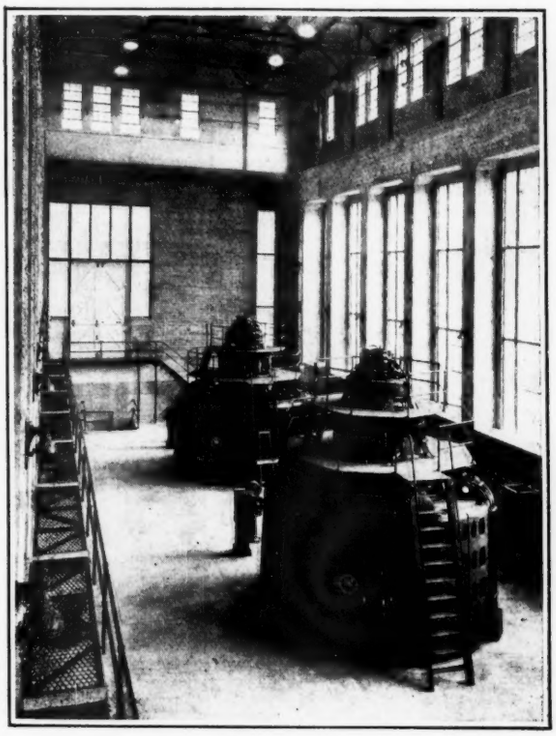


One of the "enchanted gardens" of the Skagit River valley, one hundred miles from Seattle

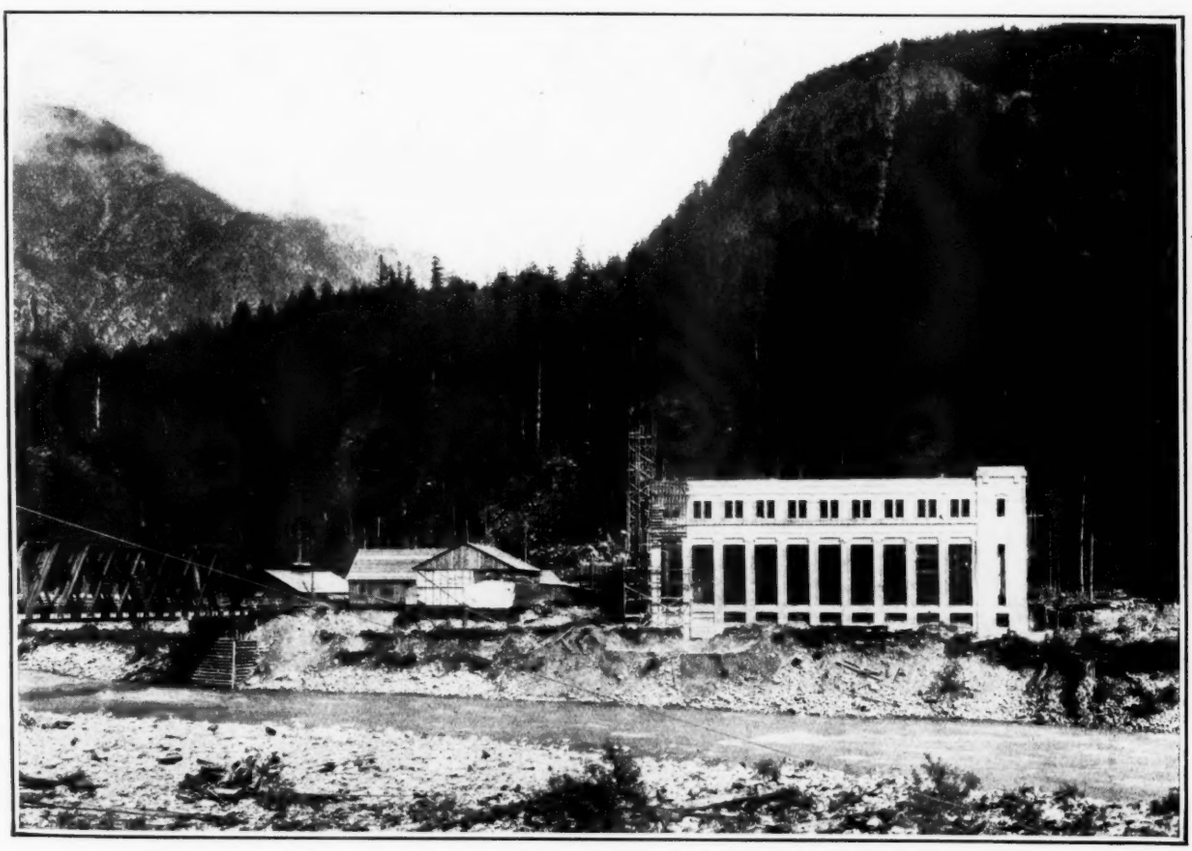
At the junction with Ruby Creek, just below the point shown, the City of Seattle will build a dam 480 ft. high to provide storage for the Gorge plant farther downstream. A 1,300,000-acre-ft. storage reservoir will be built.



Branches of twenty-foot tunnel lead to Gorge power house



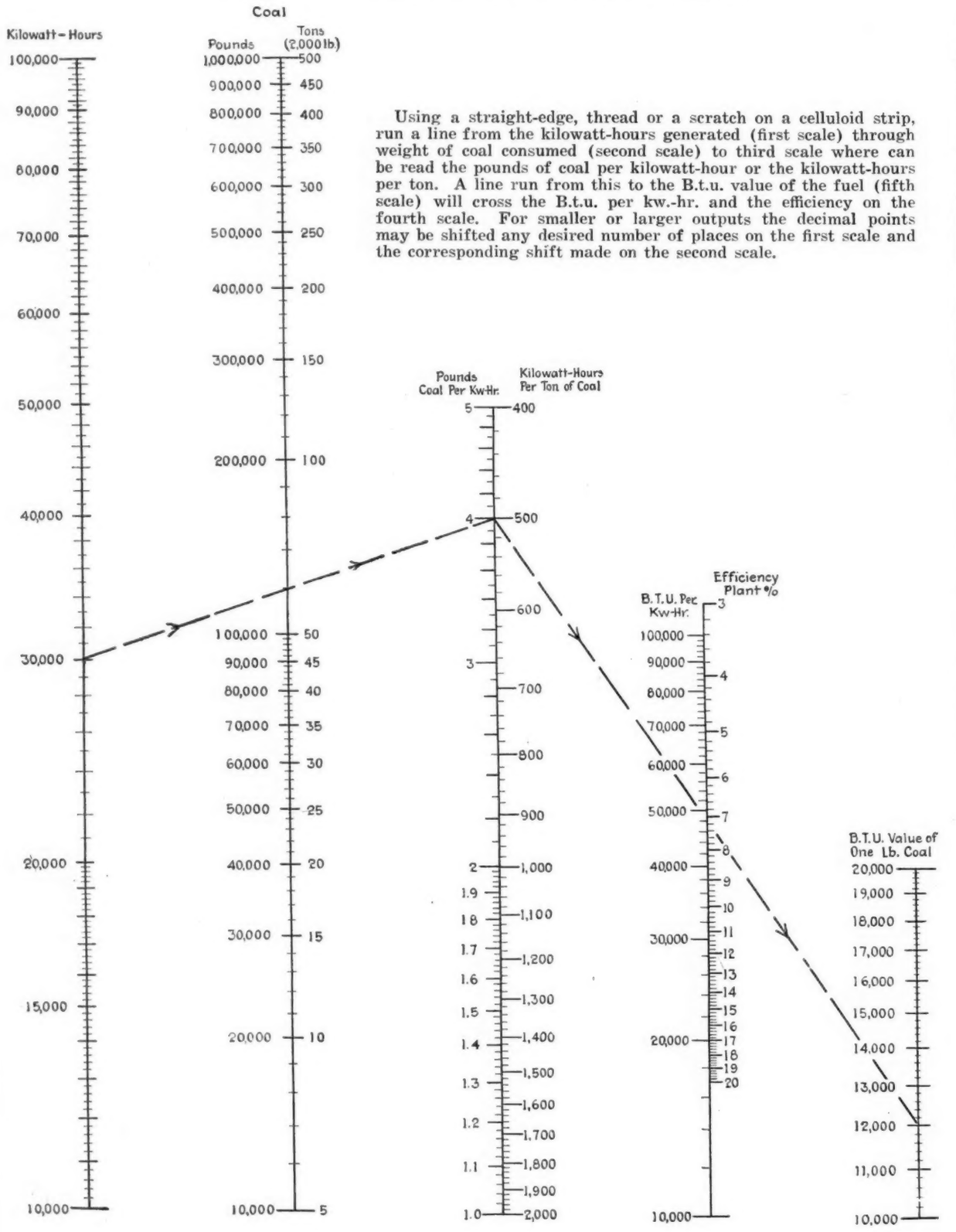
Two 30,000-kva. generators in the Gorge plant



The present Gorge plant provides 56,000 hp. at high water and 23,000 at low

Power-Plant Efficiency Chart

Designed by T. J. O'Connor, West Virginia Water & Electric Company



Using a straight-edge, thread or a scratch on a celluloid strip, run a line from the kilowatt-hours generated (first scale) through weight of coal consumed (second scale) to third scale where can be read the pounds of coal per kilowatt-hour or the kilowatt-hours per ton. A line run from this to the B.t.u. value of the fuel (fifth scale) will cross the B.t.u. per kw.-hr. and the efficiency on the fourth scale. For smaller or larger outputs the decimal points may be shifted any desired number of places on the first scale and the corresponding shift made on the second scale.

Exhaust Steam Condensed in Open Feed-Water Heaters

By L. G. Jones

IT IS often desirable to know the amount of exhaust steam that is being condensed in the feed-water heater, without going into unnecessary detail. A quick but approximate method of determining this quantity is here given for the open type of heater.

The information usually at hand in most boiler houses includes the temperature of the water entering and leaving the heater, as well as the quantity of water going to the boilers.

The quality of the exhaust steam can be obtained by the barrel method, running a definite weight of the steam into a weighed barrel of cold water and noting the rise in temperature of the water. The method of conducting and computing such a test was described in the March 10 issue. Reference to Fig. 1 will then give the total heat per pound of steam at atmospheric pressure for the given quality of steam.

The total heat contained in the exhaust steam is not all given up to cold water, as the steam is cooled only to the exit temperature of the feed water. The steam retains the remainder of its heat. Hence the heat

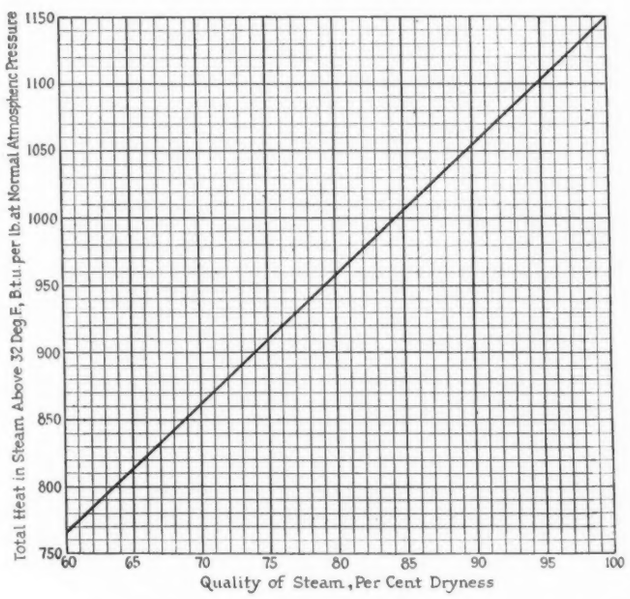


Fig. 1—Total heat (above 32 deg. F.) in a pound of wet steam at atmospheric pressure

given up by the steam equals the total heat in the steam above 32 deg. minus the final water temperature plus 32.

Entering Fig. 2 with the actual rise of temperature of the feed water, going up to the line marked with the heat given up per pound of condensed steam and then over to the left scale, one can read directly the pounds of steam condensed per 1,000 lb. of water heated. Most boiler houses measure the total condensate going from the heater to the boilers, and it must be remembered that the condensed steam is included in the water heated.

To illustrate the use of these charts, suppose exhaust steam at atmospheric pressure and 98 per cent dry is completely absorbed in an open heater, raising the water temperature from 70 to 195 deg.

Fig. 1 shows the heat content of the exhaust steam to be 1,130 B.t.u. per lb. above 32 deg. F. Not all this heat is given up, because the condensate leaving with the heated water at 195 deg. contains 195 — 32 = 163 B.t.u. per lb. The heat given up per pound of condensing steam is then 1,130 — 163 = 967 B.t.u. The rise in temperature of the water is 195 — 70 = 125 deg. Entering Fig. 2 with this value, going up

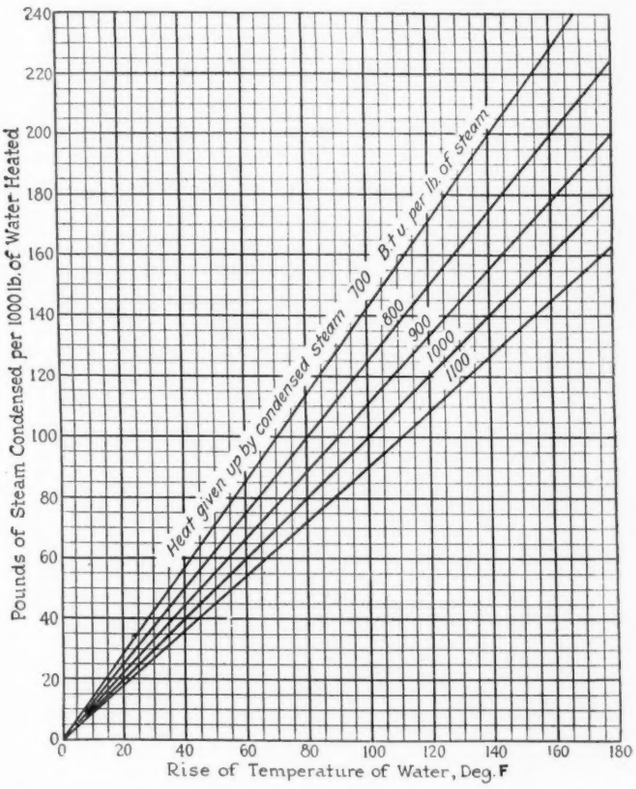
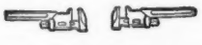


Fig. 2—Chart for finding ratio of steam to water from the temperature rise and the heat given up per pound of steam

to the imaginary line for 967 B.t.u. and over to the left scale, it is seen that the heater is condensing approximately 130 lb. of steam per 1,000 lb. of water heated. This means that 130 lb. of steam is condensed for 1,130 lb. of hot water delivered. If the water delivered from the heater amounts to 15,000 lb. per hour, the steam used is $\frac{130}{1,130} \times 15,000 = 1,725$ lb. per hour.

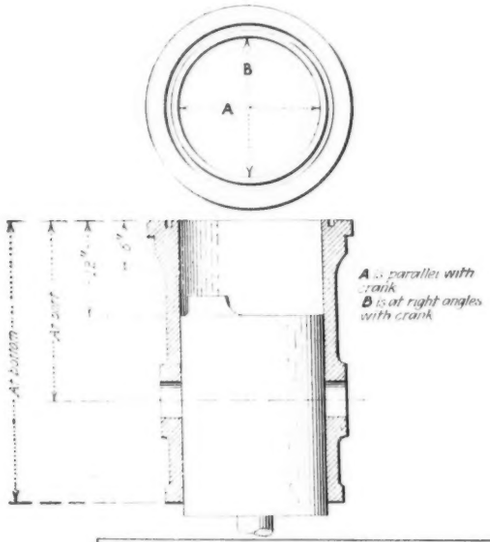
Such calculations are useful in estimating the steam consumption of boiler auxiliaries, surplus exhaust steam, exhaust steam required for desired feed-water conditions and so on.



Steam-flow meters should be taken down and cleaned out once every three months when in continuous service. The condensed steam in the meter legs often contains impurities which collect upon the surface of the mercury in the meter and on the meter float. These accumulations of foreign matter cause the meter to register incorrectly and also prevent its free movement.—*The Valve World.*

Wear of the Engine Parts

THE amount of wear to be expected in the important moving parts of an oil engine is the subject of much discussion. Unfortunately, in but few power plants are records made of the dimensions of the parts. State-

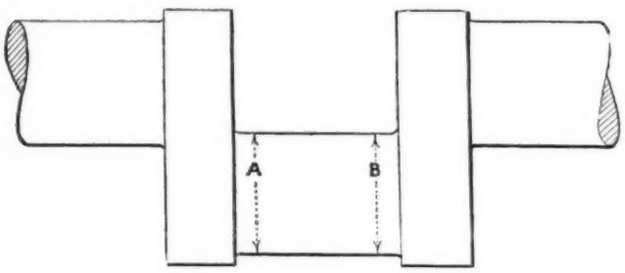


	Cylinder Wear, Inch							
	1		2		3		4	
Distance from top	A	B	A	B	A	B	A	B
6"	0.004	0.014	0.022	0.011	0.026	0.013	0.021	0.013
12"	0.008	0.005	0.011	0.004	0.009	0.007	0.005	0.005
At Port	0.005	0.005	0.009	0.009	0.007	0.007	0.005	0.005
At Bottom	0	0	0	0	0	0	0	0

Fig. 1—Wear of Diesel cylinder

ments as to wear of parts are, consequently, more or less of guesswork.

It happens that the Doubleday Page Publishing Co., Garden City, New York, maintains complete records of all adjustments, alterations and repairs made in the



	Crank Pin Wear, Inch			
Cylinder	1	2	3	4
A	0.006	0.008	0.004	0.004
B	0.004	0.004	0.003	0.004

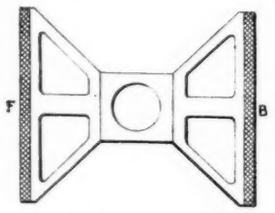
Fig. 2—Crankpin wear

power plant. Whenever a unit is overhauled, the measurements of the parts are noted down, and comparison with similar data made at a previous adjusting period reveals the extent of the wear.

At the time the company installed a 440-hp. Diesel engine, careful micrometer measurements were made of the pistons and cylinders, connecting-rod bearings, crosshead shoes and crankpins. These were entered in the plant logbook.

A year afterward the engine was given an inspection and the parts remeasured. The two sets of measurements were compared, revealing the wear in the respective parts as shown in the illustrations.

In Fig. 1 is given the wear of each of the four cylinders at points 6 and 12 in. from the top, at the exhaust ports and at the bottom of the cylinder. These sections were calipered parallel to the crankshaft and at right angles to it. It will be noted that the wear of



	Crosshead Shoe Wear, Inch			
Cylinder	1	2	3	4
Front	0	0.002	0.004	0
Back	0.002	0	0	0.003

Fig. 3—Reduction of crosshead shoes

	Crosshead Pin Wear, Inch			
Cylinder	1	2	3	4
Left Hand	0.002	0.002	0.004	0.002
Right Hand	0.002	0.002	0.002	0.002

Fig. 4—Wear of crosshead pin

all the cylinders is practically identical and that the greatest wear was parallel to the crankshaft instead of at right angles, as would naturally be expected. As on all engines, the greatest wear is at the cylinder top where the gas pressure is the maximum.

The wear of the crankpins was small, but varied more than did the wear in the cylinder. The crosshead pins showed but a slight wear, while the wear of the crosshead shoes was insignificant.

Petroleum from Microscopic Vegetables and Animals

Most of the vast oil pools of the world were built up by swarms of microscopic plants and animals, each contributing its infinitesimal bit to the total as it died and settled to the oozy ocean floor many ages ago. Junius Henderson, of the University of Colorado, advanced this thesis before the recent meeting of the American Association of Petroleum Geologists in session at Wichita, Kan. While fish bones and scales are frequently found associated with oil deposits, such deposits frequently show no traces of fish remains.

How the study of fossils aids in the location of oil was told by David White, chairman of the division of geology and geography of the National Research Council. Though the practice was started only a few years ago, many oil companies now have paleontologists on their staffs. That such studies of fossils, often of microscopic size, greatly facilitate the finding of oil and save the boring of many useless holes, is stated in the April issue of *Science*.

Railroads Urge Diesel Locomotive

EVEN conservative railroad men acknowledge that the steam locomotive creates a serious smoke nuisance in the large cities. The public demand for less soot and more clear atmosphere has caused various state railroad commissions to order the lines to electrify those portions of the tracks in metropolitan districts. The New York Central has raised an interesting point with the New York State Public Service Commission. It has been ordered to electrify, among other branches, the Putnam Division. The railroad now petitions the commission to rescind the order so far as it makes electrification imperative. The brief points out that this calls for an enormous investment which can be avoided by the use of Diesel locomotives. In Europe the oil-engine locomotive has passed beyond the experimental stage and is being built for all but heavy freight service. The investment can be made gradually, Diesel locomotives being added as the business justifies. This is in contrast to the electrification plan, wherein the entire work on a given section or mileage must be put in at once. Considering the somewhat unfavorable condition of most of the railroads, the plan offered by the New York Central is worthy of consideration, for unless electrification can be justified on the basis of return on the investment and reduction of personal discomfort, the railroads should not be called upon to bear the added burden.

An Opportunity for Further Improvement

AS EARLY as forty years ago attempts were made to utilize the energy left in the exhaust at the end of expansion in a steam engine to produce a partial vacuum in the cylinder, where the use of a condenser was not feasible.

While the improved economy attendant upon such an arrangement was appreciated, most of the efforts were made in the locomotive field with the object of increasing the power. The reason for this probably lay in the fact that in continental Europe, where most of the experimenting was carried on, there are few non-condensing stationary steam engines except where there is need for exhaust steam.

Not until three years ago did any of these attempts meet with a measure of success. About that time Professor Stumpf, whose first experiment had proved a failure, discovered that the waves produced in the exhaust reflected back into the cylinder; and in order to avoid atmospheric pressure when the exhaust valves closed, their closing must be timed with the low-pressure part of the wave. He also discovered the advantages of properly designed exhaust passages and nozzles so as to realize the full benefit of the steam velocity from one cylinder in its ejector action on the other cylinder. The unaflow design proved especially adapted to this because the opening of the exhaust ports by the piston produced a high velocity of exhaust.

With his second locomotive Professor Stumpf was able to attain a vacuum of 8 to 18 in. by this method. As a result of these experiments a third has been built in Europe and is reported to be operating successfully. A design modified to meet American practice has been laid down and is likely to be built.

The principle, if successfully applied to stationary practice, would have an almost unlimited field, for not only would the engine economy be improved, but the exhaust steam after performing this function returns to atmospheric pressure with its latent heat available for heating.

Central-station practice has been making rapid strides in the economy of generation, and if the steam engine is to remain in competition with purchased power, it must also show further improvement. This means scrapping old patterns and devoting both skill and money to development work. It is understood that at least one American unaflow engine builder is working along these lines with a view to putting an engine of this type on the market at an early date.

Crawford Avenue

UNTIL the recent introduction of the present high steam pressures and temperatures, power-generating equipment in large steam plants had become fairly well standardized. Changes in design were made, but these usually concerned details rather than radical changes in the machine as a whole. The leading article in this issue describes the new Crawford Avenue plant of the Commonwealth Edison Company in Chicago. One of the outstanding features is the operating steam pressure of 550 pounds and a temperature of 725 deg. F. But over and above this is the wide diversity in the equipment in the turbine room. Not only is the practice of two American manufacturers represented, but also one English firm. This may have been done in order to gain experience with different types of equipment under the unusual operating conditions.

The arrangement of the turbines that make up the units and the speed at which they operate show that there is a wide diversity of practice among the different manufacturers. On two of the machines, a separate high-pressure turbine, representing approximately thirty per cent of the total capacity of the unit, is used to expand the steam down to the pressure where it is reheated for use in the intermediate- and low-pressure elements. In the third unit a high- and an intermediate-pressure turbine are on the same shaft. The steam is reheated after it passes through the high-pressure element and before entering the intermediate-pressure turbine. In the English unit the reheated

steam is expanded through an intermediate-pressure element and then through a separate low-pressure element. In one of the American machines the steam from the high-pressure element goes, after reheating, to a low-pressure single-flow element, of a size that represents about two-thirds the total capacity of the unit. In the other American machine the steam from the intermediate element is expanded through a double flow element to condenser pressure. Although the high-pressure elements of all machines operate at 1,800 revolutions per minute, the low-pressure elements operate at 1,800, 1,200 and 720 revolutions per minute respectively. The largest low-pressure turbine with a rating of 43,000 kilowatts, operates at the highest speed, and the smallest low-pressure turbine, which is rated at 6,000 kilowatts, operates at the lowest speed.

In the boiler plant there is a considerable diversity of equipment. Reheating of the steam after partial expansion has made necessary the use of a special reheat boiler for each turbine in addition to the normal boilers. The boilers serving one turbine have been equipped with air preheaters and economizers, while the boilers on the other units have economizers only. These features and many others not only make this station of interest, but they also offer exceptional opportunities to obtain comparative performance of the different apparatus under similar conditions.

The Engineer Should "Get There First"

A DISCOURAGING feature and often unreasonably so, in the operation of many small plants, is the indifference of the management toward improvement of power-plant equipment. In spite of the engineer's efforts to maintain and operate economically, the neglect of those higher up may lead eventually to a day of reckoning wherein obsolete methods and piecemeal plant additions are weighed in the commercial balance and found decidedly wanting. The chief may then have the questionable satisfaction of witnessing a general overhauling at the suggestion of an engineering-sales representative or consultant.

Proceedings of this kind usually reflect little credit to the man whose best efforts for years have been spent on the power-plant equipment. If he has proposed plans equally as good, he will resent not having had his ideas accepted. If such improvements have been conceived and not reported, or if he has not been inclined to think of future progress, the omission in either case is sufficient to cause regret. It is inestimably better, if possible, to get to the management first with the right ideas and see them carried out successfully. The job then takes on a different aspect, both the management and power-plant executive being benefited.

As to how such things are best accomplished, the main considerations might be classified as keeping abreast of the times and ahead of a job, which is good advice when it can be followed. These are seldom denied to the right kind of personal application. Perhaps the most difficult of all is to present the situations so they can be well understood by those with other things more important than power cost and reliability to think of.

While repeated regular efforts may be the best means of finding out how to make the desired impression, proof that may be referred to at any time is a valuable asset. Those who are so highly engrossed with keeping a plant in condition to carry peak load, or cranes and other electrical equipment capable of a six-day grind without a shutdown, may have little time or energy to spend in writing reports. Nevertheless, the original or copy of a communication is seldom surpassed in value by other types of reference. Perhaps in many instances the engineer could better serve his own and employer's interest by greater concentration on measurements, records, calculations and such matters. Although he may have an expert knowledge of all that goes on, personal judgment is best supported by cold figures, and by seeing that the proper calculations and plans first come from the engineer in charge, an important basis will be established for future action.

Rubber in the Power Plant

RUBBER in the form of gasket materials and insulation for wires has long been used satisfactorily for many services around power plants and will continue to be so used. It has also been employed as a constituent of many forms of low-pressure and low-temperature packings for valve stems, pistons and piston rods. Rubber valves are common in vacuum pumps. Rubber hose is universally used for washing-down purposes, cooling ash, etc. Rubber belting is standard equipment on many conveyors. All these uses of rubber are of long standing.

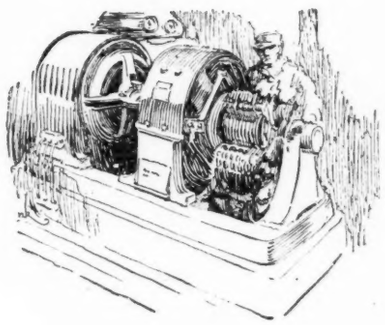
Within recent years rubber expansion joints have been used successfully on exhaust and low-pressure steam lines and in water lines. These have been so satisfactory that they have practically replaced copper expansion joints for low-pressure and low-temperature work. Their use in this field will undoubtedly extend, for several new forms are now being introduced.

A new form of grinder for pulverizing coal for boilers has recently been announced where the barrel of the drum will be lined with rubber to reduce wear and abrasion. Rubber is being tried in other equipment that is subject to rapid abrasion, and promises good results. Fans removing the powdered coal dust from air separation mills are subject to rapid blade erosion with many varieties of coal. When these blades are rubber coated, the erosion is greatly reduced and the outage of the mill for fan-blade replacements is lessened. Rubber-lined tubing and ducts have also been tried to reduce wear where this is a troublesome factor and have been especially effective at elbows in ash-sluicing systems. Rubber mats are used for insulation around electrical equipment. Rubber insulation is widely used on electrical cables.

These recent extensions in the use of rubber around the power plant have all proved of real benefit. Undoubtedly, other applications may still be developed. These remarks may start engineers considering other ways of utilizing this useful material in power plants.

Many industrial plant managements seem at last to have awakened to the advantage of placing a turbine or engine between the boilers and the process steam header, instead of utilizing live steam for process work and purchasing all their power. Turbine and engine builders report greatly increased business in high back-pressure units. Undoubtedly, the availability of standard high-pressure boilers and the experiences in central-station practice with higher steam pressures have pointed the way.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for May will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during April for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to J. F. Nagle, of Brooklyn, N. Y., for his article on "Furnaces for Burning Wet Wood Refuse," in the June 9 issue.

The second prize of $15 goes to William A. Davidson, of Wabash, Ind., for his article on "Combined Suction Air Chamber and Strainer," in the May 19 issue.

The judges were: (Chairman) Norman N. King, chief engineer, Singer Bldg., New York City; Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City, and D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City.

How to Locate a Reversed Field Coil Without a Compass

A motor trouble-shooter often bumps into some queer pranks of motors in the course of his daily work, especially those operating on direct current. And if, as is quite frequently the case, the job happens to be situated in an isolated place and proper instruments are not available, he is quite as often puzzled to know how to find the trouble. I recently came in contact with a case of this sort.

A large coal mining company had in service a 225-hp. direct-current motor driving a pump. This unit was located a short distance above a sump at the bottom of the main slope. The trouble developed when one of the four field coils absorbed moisture and burned out. The maintenance crew replaced this coil at once and tried to put the motor back into service, but it raced. The foreman jumped to the conclusion that one or more of the remaining coils were burned out and, instead of checking up on the connections of the new coil, ordered another one replaced. When this had been done, the machine was again tried, with the result the same as before.

This catch-as-catch-can method had consumed hours of valuable time, for the motor was of a type necessitating the removal of the armature in order to replace a field coil. By this time the superintendent got on the job and ordered a call sent to another mine for their electrician. When this man arrived, he did not waste time in cut-and-try schemes. Finding no compass available, he requested a strip of stiff paper the width of the armature and of sufficient length to cover the inner diameter of the pole-faces. His next request was for a small box of iron filings from the machine shop.

When these were procured, he rolled the paper in the form of a cylinder and placed it over the inside faces of the four poles. After energizing the field circuit, he began sprinkling the filings over the inner surface of the paper. The image of the magnetic circuit began to appear as the filings formed themselves in lines to conform with the field of magnetic force between the polepieces. This test disclosed three fields of like polarity and admitted of no mistake being made in correcting the connections of the reversed field.

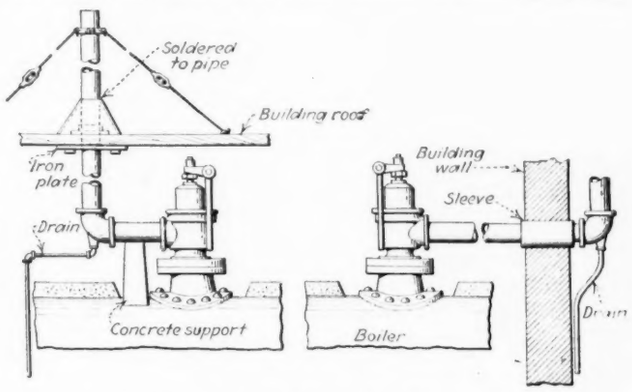
In making this test great care should be exercised to avoid getting any of the iron filings in the winding of the motor, as they are likely to cause trouble in the future.

RICHARD DIC KARD.

San Francisco, Calif.

Safety-Valve Discharge Piping

Every engineer is familiar with the danger to workmen working on top of the boilers when the safety valves discharge into the boiler room. To eliminate this



Arrangement of safety-valve discharge pipe

danger we have piped the safety valves to discharge through the roof. At first we ran the pipe through the wall as shown in the view at the right of the illustration, but the continual freezing of the drip pipe caused endless trouble.

The view at the left of the illustration shows the final arrangement of the piping. A concrete block was made to support the pipe, and where it goes through the roof a plate of ¼-in. iron is screwed to the roof. The hole in the plate is made a close fit to keep the pipe from vibrating, but with sufficient clearance to allow it to expand. On the top of the roof a sheet-iron collar is fastened to the pipe with a cone-shaped piece over it as shown, the upper end of the cone being soldered to the pipe. Although a brace is shown on the pipe, this is necessary only when the pipe extends more than eight or ten feet above the roof. Turnbuckles are inserted in the braces to facilitate tightening them to the proper tension. The collar on the pipe to which the braces are attached is made of ½x1½-in. bar and tapped to receive three ⅜-in. screw-eyes. Care should be taken in tightening the braces to avoid undue strain on the valve and threaded joints.

GORDON A. PHINNEY.

Needham Heights, Mass.

Home-Made Ejector for Handling Bagasse Makes Big Saving in Labor

There are few industries that are fortunate enough to have a waste product that can be used for fuel, the lumber industry being one of the fortunate ones. Another not quite as well known is the sugar mill or central, some being so fortunate as to have enough of the ground cane, otherwise known as bagasse, to supply all their power purposes; most centrals, however, have to use in conjunction either wood or fuel oil or both.

In most cases it is possible to operate the sugar mill and boiler plant so that little extra fuel need be used. It has been demonstrated at two or three sugar centrals in Cuba as well as other sugar-producing countries that the ordinary mill can supply enough bagasse for all the power required and in addition, all the steam for evaporating or processing in the sugar house. It might be mentioned here, that this refers to mature cane and that the boilers must be kept in good condition and the tubes kept clean.

At Central Elia, Camaguey, Cuba bagasse has been used wholly for fuel since the first of the year, supplying the necessary steam for all purposes besides creating a big supply in storage for the dead season. This means that steam was supplied for not only the necessary power for the mills, but for all boiling purposes, including cranes, refrigerating plant and power plant, which supplies electricity for the company property

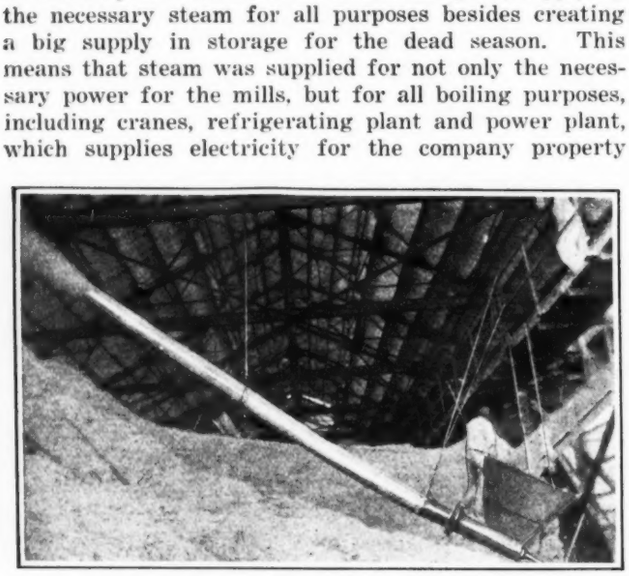


Fig. 1—Ejector in operation handling bagasse in storage house

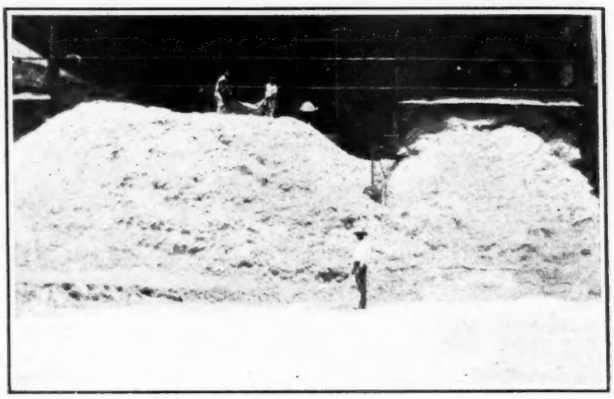


Fig. 2—How the bagasse was handled before ejector was used

and for the town of Elia as well, the total steam requirements amounting to approximately 200,000 lb. per hour, twenty-four hours per day, beginning the first of December and continuing until the latter part of May.

Bagasse is taken from the last set of rolls on the mills by drag conveyers and discharged to a main carrier located over the boilers, carried the length of the boilers and then dropped at one or more points and fed to the several boilers as required through necessary ports, the surplus being carried on to the storage houses.

At the central previously referred to, it became a problem to find sufficient storage space for the surplus bagasse, and until an ejector had been designed it was hard to find the necessary help to handle this material.

On account of these conditions a steam ejector was made from old piping found in the yard. A piece of 10-in. pipe about 6 ft. long with an opening cut on one side, formed the body of the ejector. A feeding hopper was welded on as shown in Fig. 1. Steam at 160 lb. pressure was supplied through a 1-in. pipe located in the center of the 10-in. pipe. Fig. 1 also shows the ejector in use throwing the bagasse up under the eaves of the storage house; this eliminated the work of fifteen men.

In Fig. 2 is shown an end view of the storage house, also the method of handling the bagasse before the ejector was installed. Previous to using the ejector, the bagasse was delivered to the storage house and passed down the inclined chute shown in Fig. 1, where it dropped onto a canvas about 8 ft. square. When sufficient had been collected, two men gathered up the corners of the canvas and dragged it to the outer edge of the storage. Since the use of the ejector the bagasse has been delivered about ten feet above the eaves, with the use of one attendant only.

After finishing inside the storage house, the ejector is taken out in the yard and used to deliver bagasse to the conveyor. This has not only saved the company considerable money, but has eliminated a troublesome labor situation.

As shown in Fig. 1, galvanized iron pipe was used for delivery and this was about 25 ft. long, the ejector throwing the bagasse over 60 ft. up under the roof.

For this particular job an exhaust fan would probably have been much better if one had been available, but under the circumstances the ejector was the only piece of apparatus that could be made conveniently from material at hand, and it has proved very economical.

Elia, Camaguey, Cuba. EDWIN C. BLISS.

Comments from Readers

What Is the Best Method of Repairing a Girth Seam?

In the Feb. 10 issue R. C. Ragsdale asked about the best method of repairing a girth seam, and some suggestions have already been made by other readers. It would seem to me that the original workmanship on the boiler was not first-class or the joint would not have leaked so soon. He does not say where the bridge wall is, in relation to the joint. If the seam is so near the bridge wall that the flame strikes the wall, then shoots up, hitting the seam, it might cause leaking. There are two thicknesses of metal in a seam, and with a flame playing directly on the joint it may cause the outer lap to get too hot, so much sometimes that it causes fire cracks from the calking edge to the rivets. Mr. Ragsdale says that twelve rivets were cut out and new ones driven in, but in a few weeks these rivets were removed again, the plate heated and laid up hot, but after it was leaking again. He also says the rivets were driven with an air hammer.

From this it would appear that the man who repaired this seam was not a first-class boilermaker; if he had been, he would not have driven the rivets with a pneumatic hammer. Furthermore, he would not have heated the plate to lay it up unless there was considerable slack in the plate, too much to draw and lay up cold. If there was so much opening between the plates that it was necessary to heat the plate to draw it up, then we certainly know why the seam could not be kept tight.

To lay up the joint, all that was necessary was to cut out the rivets, put a good bolt in every second hole and tighten them up, then have a man go inside and hold a sledge or bar over the hole while the boilermaker laid up the plate from the outside. After the plate is up tight, put a bolt in the hole and remove the next bolt and lay up another section of plate and so on until all the plate is back in place. Then ream out the holes just enough to bring them in line and finally make them $\frac{1}{32}$ in. larger than the rivet to be used.

When ready to drive the rivets, have a man inside of the boiler with a big holding block or sledge and be sure to get the rivets in white hot and drive them straight in the hole so they will be upset right back to the head. If the plate is up fairly tight when cold, it will be drawn much tighter when the rivets cool off. The pneumatic hammer forms the head on a rivet so rapidly that the hole is not properly filled.

It is my opinion that to weld along the inside edge of the seam and around the heads of the rivets, as he suggests, would be the worst thing he could do and when the welding was finished, every rivet would probably be so loose you could shake them in the hole. This would allow water to enter the joint above where it was welded and work down and come out on the outside.

I am not enthusiastic about gas welding on boilers. It is satisfactory in cases where the article to be welded can expand and contract, but on a boiler it is much different, as the plate is all cold except where welding is being done. In welding boiler plate the increase in temperature due to the flame tends to set up enormous strains, and as the plate becomes heated up this strain releases itself by upsetting the metal in the heated portion. But when the plate begins to cool, the stress is reversed, and either the weld pulls apart or there is a heavy stress left in the plate.

During the last twenty-five years I have repaired many different makes of boilers, and the practice has changed considerably in that time. For the last seven years it has been our custom to electric weld these joints if they are fire cracked. We first make sure that the rivets are good, then cut a V in the crack, leaving an opening at the bottom of the V large enough to weld onto the inner plate, then weld the V full; also welding on to the shank of the rivet and around the rivet head, finally welding the seam along the calking edge from wall to wall. The heat from electric welding is local and sets up no strain if done properly. In many places where patches had been riveted and could not be made tight, we have welded them and made a permanent job.

I might mention in this connection that there are many "would be" electric welders in the field and it is well, when repairing a boiler, to obtain an experienced man. To do electric welding overhead one must be an expert, and the overhead weld is the best when properly done. When welding downhand, all the slag and other waste fall into the weld. When the welder first draws the arc, the first few drops of metal fall into the weld, causing what we call pinholes, but when the welding is done overhead, only the good metal will stick, which gives a good weld if the work is properly done.

Mr. Ragsdale's trouble calls to mind a case I had a few years ago. A certain company in South Carolina was having about the same trouble with the front girth seam on one of its boilers. The rivets had been removed and replaced a number of times. Several repairmen had tried to find out the cause of the leakage but failed. Upon examination I found it was oil that was causing the trouble.

Two years later they wrote again, saying another girth seam had given out in another boiler, and asked to have the same man that repaired the seam on the other boiler. Examination of this boiler showed that there were twenty-two cracks in the seam. These were all V-cut and electric welded, also the rivets and seam along the calking edge as previously explained. Some may ask how a first-class job can be done where there are so many fire cracks. I would answer this by saying that it makes a much stronger job where there are fire cracks, because the plate is welded to the shank or body of the rivet. Also, the two plates are welded together from calking edge to rivet, making it like a solid plate.

It is a mystery to me why the engineer who is having a new horizontal return-tubular boiler built does not insist on having the first girth seam electric welded before the boiler leaves the boiler shop, especially if the water that is to be used in the boiler is bad.

New Haven, Conn. G. A. FIDLER.

The Use of Air Chambers on Pumps

In looking over my stored away *Powers* I noticed an article published last fall on "The Use of Air Chambers on Pumps," which brings to mind an incident that occurred several years ago in a water-works plant where I was employed. The old steam direct-acting pumps had been replaced with two 450 gal. per min. centrifugal motor-driven three-stage pumps and one 750 gal. per min. fire pump of the same type. These pumps would lose their prime, and it usually required considerable time to make them pick up their water on starting.

The suction of the pumps had a total length of 34 ft., 20 ft. of which was horizontal with a 14-ft. vertical section fitted with foot valves at the lower end.

As a means of overcoming the trouble I suggested that we drill a 1-in. hole in the top of the suction lines about 2 ft. from the suction connection at the pumps and connect an air chamber made from a piece of 4-in. pipe about 4 ft. long fitted with an air tight pet-cock in the top end.

I was discharged from the plant as chief engineer a few days later for dictating to the superintendent, but I had the satisfaction of seeing my air chamber prove a success on the pumps.

I never happened to be back in the plant until the other day, and I noticed the air chambers were still on the suction lines where I placed them, and in use. I asked the engineer how they worked, and he said the pumps never failed to pick up the water and had never lost their prime since the installation was made.

Ponca City, Okla. V. K. STANLEY.

Utilizing Waste Firebrick

In the April 21 issue James Johnston takes exception to the economies in the use of waste firebricks, as outlined in the article by Joseph Harrington in the June 17, 1924, issue. Judging from Mr. Johnston's statement, he has a limited amount of brick maintenance, and it surely would not pay any plant to keep men standing around waiting for a boiler to need repair and then get ready and make refractory material to repair the walls.

It is probably true that the methods we recommend are beneficial only to certain plants. Plants that are not large enough to justify the installation of the proper machinery to prepare the mortar, to get the plasticity and tensile strength necessary for success, or in which the engineer is too busy to give the matter enough attention to get the proper blends of clays and their possible blending with the ground bricks to be used, would be better off to buy their bonding material from reputable refractory manufacturers. We have seen engineers mix high-grade brick dust having a fusion point of over 3,000 deg. F. with fireclay showing a fusion point of 2,645 deg., and then wonder why they did not get results with their joints of plaster or gunite.

We have no personal acquaintance with conditions in South America and would not presume to advise on methods of work there. We will be glad to furnish Mr. Johnston with data from two large power plants in this country where some of the largest pulverized-fuel fired boilers are in operation. These plants have been using ground brick mortar for the last two years. On Dec. 8, 1924, a test on a side wall was started, over 5,000 firebricks were laid up in a 9-in. wall, ground firebrick mortar being used for the joints, which were made from $\frac{1}{8}$ to $\frac{3}{16}$ in. thick with sufficient expansion joints allowed. The mortar was made from carefully selected brickbats from which all slag and other contamination was cleaned and a blend of clays, and all ground together in a wet pan into a fine soft mortar.

Four months later this boiler was taken off for inspection. It was found that of more than 10,000 joints not one was fractured or burned out and not a single brick had spalled. A portion of the wall where the heat had been the most intense and the erosion the greatest, was removed and it was found that the 9-in. bricks were just 8¼ in. long.

In figuring the economy of this test, it must be considered that the mortar costs less than high-grade fireclay and not more than one-fourth the cost of the high-temperature cement formerly used, and a $\frac{3}{16}$-in. joint saves about 12 per cent of bricks.

Walls of this kind, built solid, where the hot gases have no chance to penetrate and weaken the wall, need no application of plaster of any kind and very little repairing.

Constructive work done by engineers who give the matter their careful attention, as is done in the plant referred to, will do more to put ground brick mortar in its proper place than anything else.

JAS. A. FAULKNER, Prest.,
J. A. Faulkner Refractories Co.
Youngstown, Ohio.

What Idler Pulley Gives the Best Results, Crowned or Concave?

We have had experiences with governor belts climbing the flange of the governor pulley, similar to that described by Mr. Fette in the May 12 issue, and have found on taking off the belt that it was stretched on one side, as he states. On complaining to the firm that furnished the belting, they said that their records showed it was all first-quality backbone center stock, but they replaced it with a new belt that ran true without any change in the idler, which was crowned face and flanged similar to the drive shown by Mr. Fette. We are therefore inclined to credit the trouble to uneven stretch in the belt before it climbed the pulley flange, rather than to blame the stretching of the belt to climbing of the flange, as the belt maker did.

It is true, however, that more care should be taken in providing proper bearings and carrying supports for governor belt idlers, for while the usual attachment forming part of the safety-stop gear in case of breakage of the governor belt is too light to force the belt badly out of line, I have seen other idlers, heavier in proportion to the belt weight and tension, in which inaccurate alignment of the idler with the other shafts forced the belt badly to one side of the pulleys. It seems likely that unless the belt has a considerable angle of wrap on the idler such as used with certain short belt drives, it is of little consequence whether the idler is hollow, flat or crowned and that the flanges are provided chiefly as a guide to hold the idler on the belt and overcome the effect of insufficient supporting mechanism for it. Our experience has been, with both large and small idlers, that where a stiff framework can be used which will hold the idler shaft in line with the other shafts of the drive, a straight-face idler without flanges will give the most satisfactory results.

New Haven, Conn. H. D. FISHER.

Measuring Coal on Traveling-Grate Stokers

I should like to make a few comments on the contribution by J. R. Darnell in the April 21 issue, entitled "Measuring Coal on Traveling-Grate Stokers."

Unless the records of coal consumption are made with a degree of accuracy sufficient to enable the operator to determine whether his plant is being operated at its best, they are useless. Unless the records are scrutinized for the purpose of detecting where improvements in the plant operation are possible and practicable and unless improvements are made, the making of such records is an additional waste in what, very likely, is a wasteful organization already, for efficiency and economy are incompatible with such records as determining the coal consumption from the stoker travel, and the total water evaporated by multiplying an approximated coal consumption by an assumed evaporation per pound of coal. That sort of "computation" is responsible for an annual waste running into millions of dollars, not only in small plants but in plants of considerable size. To illustrate, the power superintendent of a plant consuming about 250 tons of coal a day, repeatedly and in all sincerity stated that his boiler room was being operated at an efficiency of 80 per cent. He had records to back up his statement. A mere inspection of the condition of the boiler room convinced me that it would be a physical impossibility to get an efficiency of over 50 per cent. Measurements indicated that the CO_2 varied between 4 and 7 per cent and the temperature of the exit gases was nearly 1,000 deg. F.

Measurements and computations such as suggested by Mr. Darnell are, in my opinion, inexcusable in power-plant work except in an emergency and for rough estimating purposes. Carefully calibrated instruments will earn good dividends even in small plants, in some cases as high as 300 to 400 per cent per annum.

Mr. Darnell deserves credit, however, for calling attention to the rationality of the principle of volumetric measurement of coal. But his application of that principle is, I think, too coarse to yield results of any value to the power-plant operator. Consider the measurements involved. The volume of coal consumed is evidently equal to the product of the width of the stoker, the distance traveled and the thickness of the fuel bed. The width of the stoker is fixed, the travel may be measured with a fair degree of accuracy, particularly over a period of several hours, such as an eight-hour shift. Consequently, the accuracy of the results is dependent solely upon the accuracy of the measurement of the thickness of the fuel bed which cannot be determined with reasonable accuracy unless a number of careful measurements are made along the front of the stoker. Certainly, the position of the gate cannot be relied upon for indicating the thickness of the fuel bed, as for the same position of the gate the thickness may vary as much as 15 to 20 per cent, for several reasons. This fact was clearly brought out in the discussion at the Fuel Saving Conference of the A. I. & S. E. E., at Pittsburgh, Pa., April 2 and 3, 1924, and published in the *Iron and Steel Engineer*, June, 1924. The rationality of the principle of volumetric measurement of coal has been investigated by several observers and found correct. As a result there are several devices on the market based on that principle. But, it would appear that in some of these devices that principle has been applied almost as coarsely as suggested by Mr. Darnell, with the inevitable unsatisfactory results.

It is rather unfortunate, but a revolution counter attached to a stoker will not make it a coal meter any more than a revolution counter attached to a pump will make it a water meter.

E. OGUR.

New York City.

Amount of Water for Condenser

In the March 17 issue T. E. F. brings up a question regarding the amount of cooling surface and cooling water required in an ammonia refrigerating plant. There are, however, several practical considerations that would vary the results obtained considerably.

Using the values given, 728 gal. of cooling water per minute and a cooling surface of 1,076 lin.ft., or 1,537 ft. of 2-in. pipe would be required. An atmospheric condenser in common use is made up in stands, each stand 12 pipes high and 20 ft. long, or 240 lin.ft. of 2-in. pipe per stand. There would be required 1,537 ÷ 240 = 6.4 stands. If 7 stands be used, 728 gal. of water per minute ÷ 7, or 104 gal. of water per minute, must be put over each stand. In practice not more than 42 gal. of water per minute can be circulated over each stand of condensers of this type without considerable waste due to splashing off the pipes, and 30 gal. per minute per stand is nearer the usual limit.

With condenser pressure not to exceed 190 lb. gage, allowance must be made for uncondensable gases, which are always present in an ammonia plant and which increase the pressure corresponding to that of ammonia in a pure state. It is unusual to find a plant in which the condensing pressure is less than 12 lb. per sq.in. gage above the pressure corresponding to that of the liquid ammonia leaving the condenser. In this case, allowing 12 lb. in excess condenser pressure due to the presence of foreign gases, 190 — 12 = 178 lb. per sq.in. gage will be the pressure of the ammonia. From the ammonia tables the corresponding temperature of the liquid would be 94 deg. F.

Atmospheric condensers of the ordinary type require from 25 to 30 sq.ft. of surface per ton of refrigeration to bring the liquid temperature to within 5 deg. F. of the temperature of the water passing off; while the atmospheric bleeder type needs from 17 to 20 sq.ft. per ton, each type using from 3 to 3½ gal. of water per minute per ton of refrigeration.

The heat removed by the condenser is 42,526 B.t.u. per min., of which 40,796 B.t.u. was added in the evaporating system; this is equivalent to a duty of 203 tons of refrigeration. Assuming that the atmospheric bleeder type is chosen, with 203 tons of refrigeration and 20 sq.ft. per ton, 4,060 sq.ft. of surface would be required or 6,496 lin.ft. of 2-in. pipe. The number of stands, figuring 240 ft. per stand, would be 27.

The temperature of the ammonia liquid leaving the condenser will probably be about 3 deg. F. above that of the water passing off; the latter will be about 91 deg. F. The water required will be 42,526 B.t.u. ÷ (91 — 85) = 7,087.7 lb., or 850.8 gal. per min., and 850 gal. per minute ÷ 27 stands gives 31.5 gal. per min. per stand.

No allowance has been made for the usual 10 per cent loss due to water splashed and blown off the coils. Care in the construction and housing of the condenser should be taken so that all the water circulated does effective cooling work.

H. N. ROYDEN.

Hollywood, Calif.

Questions and Answers

Conducted by

Franklin Van Winkle

Greater Chimney Capacity from Increase of Height

What would be the percentage increase in capacity of a brick stack 85 ft. high if, with the same size of flue, the height is increased to 125 ft.? *B. N.*

For the same temperature of chimney gases the pressure or force of draft at the base of the stack would be 125 ÷ 85, or 1.47 times the present. The velocity of the gases would be as $\sqrt{85}$ to $\sqrt{125}$, or as 9.2195 to 11.1803, and therefore the chimney capacity would be increased (11.1803—9.2195) × 100 ÷ 9.2195 = 21 per cent.

Warping of Fire Tubes of Boiler

What would cause one tube of a fire-tube boiler to become warped or kinked more than others in the same same horizontal row? *A. F.*

If the tube was under stress from cold bends, such as would result from rough handling or from straightening before it was set in the boiler, such stresses in the material would draw it more out of line with each repeated heating and cooling and more especially if the cooling was sudden, as by admission of cold air through the firedoor for the purpose of checking a hot fire.

Length of Open Belt

What is the rule for finding the net length required for an open belt? *W. S. G.*

The best method is to measure the length directly by passing a tape line around the pulleys. When this cannot be done, an approximate formula for use is,

$$\text{Length} = 2L + 3.1416\ (R + r) + [(R - r)^2 \div L]$$

in which all dimensions are in feet or in inches, where L = the distance between centers of the pulleys, R = the radius of the larger pulley, and r = the radius of the smaller pulley.

Noisy Admission Valves of Low-Pressure Cylinder

In running a Corliss cross-compound condensing engine with light load, which happens when the water power of the plant is not quite sufficient for carrying the whole plant load, we are sometimes annoyed by pounding of the admission valves of the low-pressure cylinder. Earlier compression seems to make the noise worse. What may be the cause and cure for this trouble? *B. N.*

Probably at some loads the receiver pressure is so low that compression goes higher than the receiver pressure with the result that the admission valves are lifted. To prevent this, raise the receiver pressure by shortening the relative cutoff of the low-pressure cylinder or reduce the compression. In ordinary valve setting the compression would be reduced by setting the eccentric backward, and with a single eccentric this would require resetting of the steam valves. If only a small reduction of compression is necessary, it could be obtained most conveniently by adjusting the length of the exhaust-valve rods to obtain later release and later closure of the exhaust valves. Care should be taken that the reduction of compression is not carried so far as to lose the cushioning necessary for smooth running of the engine.

Vacuum Line on Indicator Diagram

How is the true vacuum line made on an indicator diagram? *R. C. M.*

A line on the diagram representing true vacuum, or absolute zero pressure, would be below the atmospheric line a distance that represents atmospheric pressure, and as 0 pressure cannot be actually indicated, the true vacuum line must be drawn with pencil and straightedge. On diagrams taken at sea level the true vacuum line is to be drawn below the atmospheric line and parallel to it at a distance which, according to the scale of the indicator spring, represents 14.7 lb. per sq.inch.

Location of Air Intake for Forced Draft

We have a battery of boilers using about 1½ tons of coal an hour with forced draft. Would it pay to take air for the fan from the ceiling of the boiler room where the air temperature is about 40 deg. F. higher than at the floor level? *O. W.*

Although the present air temperature near the ceiling may be 40 deg. F. higher than the temperature at the present air intake, by drawing the air supply from the upper part of the boiler room the resulting temperature would be reduced more nearly to the present temperature of air near the floor, and it is not likely that the improvement of furnace economy would be appreciable. However, removal of heated air from the upper strata of the room undoubtedly would improve conditions for boiler-room operatives, and in that respect the change of fan intake should pay for itself in a short time.

Removing Oil from Exhaust-Steam Heating System

Is it good practice at each shift to feed about a pint of gasoline or kerosene into an exhaust-steam heating system, having about 30,000 sq.ft. of radiation, for the purpose of clearing deposits of cylinder oil which may pass the exhaust-steam oil separator? *W. J. L.*

Gasoline would be objectionable from increasing the fire risk. A pint of kerosene fed twice or three times daily into a system containing 30,000 sq.ft. of radiation would not be very effective. There should be little trouble from the use of a good oil separator. If traces of oil left by it are considered to be objectionable, connections should be arranged to clean out groups of radiators from time to time by fillings and flushings with kerosene. When a group has been flushed and drained, it should be blown out while other groups of radiators are temporarily shut off.

Transformer Connections on a Four-Wire Three-Phase Circuit

How are three single-phase transformers connected on a 4,000-volt four-wire three-phase circuit to step down the voltage to 230 volts for power purposes and to 115 volts for lighting? *M. W.*

The connections of the transformers to accomplish the foregoing requirements are shown in the figure. Standard transformers designed for 2,300 volts on the high-voltage side and 115 and 230 on the low-voltage side are used. These transformers are connected star

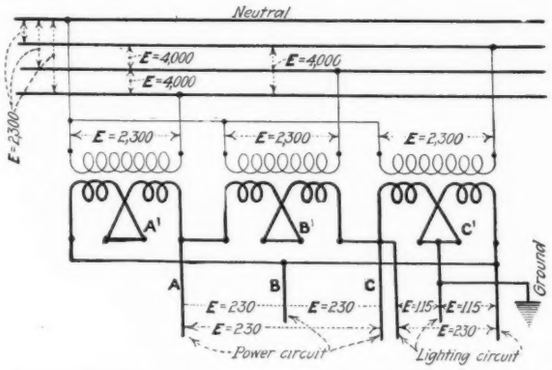


Diagram of three transformers connected star-delta on a four-wire three-phase circuit

on the primary and delta on the secondary. Connecting the primary windings in star makes the grouping good for a voltage 1.732 times the rating of the transformers, or in this case 2,300 × 1.732 = 3,983, or approximately 4,000 volts. On the secondary side the three three-phase leads are brought out for power purposes and three leads from one transformer are run for a three-wire 115- and 230-volt lighting circuit. It is best to use the three-wire lighting circuit, as this distributes the load on all the secondary winding of the transformer. If the lighting load does not exceed 10 or 15 per cent of the normal rating of the transformer, it will probably be found that the transformer can take care of it satisfactorily. The three-phase power load is distributed equally between the three transformers, so that the lighting load is additional on the unit supplying this load. If the latter represents a considerable percentage of the total load on the transformers, it may be necessary to distribute this load between all three transformers. In no case can the neutral of more than one transformer be grounded. If there are single-phase motors on the system, they can be used to help balance the load on all three transformers, by connecting them between leads *A* and *B*, also between *A* and *C*. This would put the single-phase motor load on transformers *A'* and *B'* and the lighting load on transformer *C'*.

Multiplying Sheaves on Hydraulic Elevators

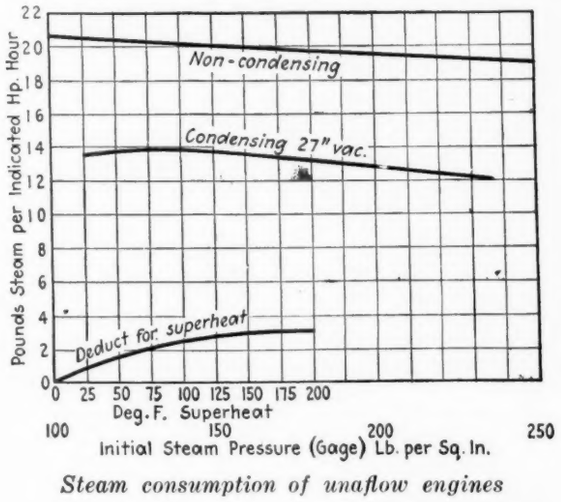
What are the positions and functions of the multiplying sheaves on hydraulic elevators? *M. E. W.*

On the vertical-cylinder type machine one or more sheaves are located on the traveling crosshead to which the piston rods are attached. At some point in the shaftway above these are mounted one or more stationary sheaves. The hoisting cables start from a fixed point in the shaftway, travel downward to the lowest sheave on the crosshead, upward to the lowest stationary sheave, downward to the next lowest sheave on the crosshead, upward to either another stationary sheave or to the overhead sheaves, as the case may be. From the overhead sheaves they travel downward to the car. On the horizontal pushing type one set of sheaves is mounted on the closed end of the cylinder. One end of the hoisting cables is fastened at a dead point, consisting of a lug on the cylinder head. From this point they travel first around one traveling sheave, starting over its top, then around a stationary sheave, to another traveling sheave, to another stationary sheave, continuing around all the sheaves, and from the last stationary sheave they travel upward to the overhead sheave and downward to the car. The function of the multiplying sheaves is to secure a length and speed of car travel in excess of the length and speed of the piston travel, it being impracticable to have the piston travel equal to that of the car, except in the plunger-type machine, where the cylinder goes down in the ground to a distance approximately equal to the car travel.

Steam Consumption of Unaflow Engines

What is the relative steam consumption of unaflow engines, operating non-condensing and condensing, when supplied with superheated steam in place of dry saturated steam? *T. R. S.*

The chart shows the steam consumption per indicated horsepower-hour to be reasonably expected of unaflow engines when operating non-condensing and also condensing with 27 in. vacuum, at normal load when supplied with dry saturated steam at initial gage pressures 100 to 250 lb., and the reduction in steam consumption per indicated horsepower hour when the initial steam is superheated 0 to 200 deg. F. For example, with dry saturated steam at the initial pressure of 150 lb. gage when operating condensing 27 in. vacuum the steam consumption would be about 13.5 lb. and when operating



Steam consumption of unaflow engines

non-condensing, about 20 lb. per indicated horsepower hour. When there was 175 deg. F. of superheating, the steam consumption would be reduced about 2.5 lb. in either case. That is, for operating condensing the consumption would be about 13.5 — 2.5 = 11 lb., and non-condensing about 20 — 2.5 = 17.5 lb. per indicated horsepower-hour.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Short-Cut Calculations

SOME of the textbooks give short-cut methods for carrying out certain computations. The methods shown are generally based on what may be called exact arithmetic. Yet some of the most interesting and useful studies in mathematics are those relating to approximate computations. The use of approximations by no means implies looseness or carelessness. In fact, the knowledge of the permissible error in various types of problems is one of the earmarks of the skilled practical mathematician. Beginners in engineering computations are prone to write out long strings of digits. With more experience they learn to cut off the tails of these strings to bring them down to the number of figures warranted by the accuracy of the data and the use to be made of the answer.

There are all degrees of approximation. A certain approximate computation might give an answer within one per cent. This would be close enough for such a purpose as estimating the strength of a bolt. Here the figures used for the unit tensile strength cannot in any case be trusted within one per cent. Moreover, a large factor of safety must be used to cover unknown factors. Only the first two or three figures in the strength of a bolt have any practical significance.

In some other circumstance five "places of figures" (not five "decimal places") might be worth while. This is the case with some steam-table work where one large value for total heat is to be subtracted from another of nearly the same size. There a difference of one per cent in one of the original values will sometimes introduce an error of 10 per cent into the difference.

The thing to do is to use the easiest available method of figuring that will give sufficient accuracy for the purpose at hand. The ordinary slide rule gives approximate answers, the error generally running from one part out of a thousand to one out of five hundred. This is close enough for the majority of engineering problems. Four-place logarithmic tables give a closer approximation, generally to one part out of 10,000. By using more and more places the error can be cut to limits required by the most refined scientific work. Yet fifteen-place logarithms, which represent an almost inconceivably small error, are, strictly speaking, approximations.

All engineering computations go back to data that are either assumed or measured. All measured quantities are approximate, although the approximation may be extremely close—for example, where a surveyor measures the distance between two points about one hundred feet apart with a precise steel tape stretched to a definite tension and corrected for temperature.

All the short-cut computations to be shown here are approximations, but the amount of error can generally be kept far below the limit required in practice. They will be useful to those who have trained their mathematical judgment sufficiently to estimate the amount of the error and its importance to the problem at hand.

Powers and Roots of Numbers Close to Unity

When a number lies within 3 or 4 per cent of unity, between 0.96 and 1.04 say, it is a simple matter to extract any root or raise to any power within reasonable limits. The higher the power and the greater the difference between the number and unity, the greater the error. The rule is this:

$$(1 + a)^n = 1 + na; \quad (1 - a)^n = 1 - na$$

Applying this to an actual problem,

$$(1.013)^2 = (1 + 0.013)^2 = 1 + (2 \times 0.013) = 1 + 0.026 = 1.026$$

In the same way, $(1.013)^3 = 1 + (3 \times 0.013) = 1.039$. As another example, take this:

$$(0.982)^3 = (1 - 0.018)^3 = 1 - 0.054 = 0.946$$

With this rule the following answers may be written by inspection:

$(1.01)^2 = 1.02$	$(0.99)^2 = 0.98$
$(1.01)^3 = 1.03$	$(0.99)^3 = 0.97$
$(1.01)^4 = 1.04$	$(0.99)^4 = 0.96$

The error involved in this method is generally negligible where the final answer is within 4 or 5 per cent of unity, but increases rapidly as this difference becomes greater. For example: $(1.015)^3 = 1.045$ by the rule and 1.0457 by actual multiplication, the error being less than one part out of a thousand. On the other hand, $(1.1)^3 = 1.3$ by the rule and 1.331 by actual multiplication, giving an error of about 2 per cent.

The same method can be applied where the power is a decimal or fraction. For example:

$$1.023^{1.6} = (1 + 0.023)^{1.6} = 1 + (1.6 \times 0.023) = 1.0368$$

Again,

$$(0.973)^{0.8} = (1 - 0.027)^{0.8} = 1 - (0.8 \times 0.027) = 1 - 0.0216 = 0.9784$$

Roots are easily handled as fractional powers. For example,

$$\sqrt[3]{(0.964)} = (0.964)^{\frac{1}{3}} = (1 - 0.036)^{\frac{1}{3}} = 1 - (\tfrac{1}{3} \times 0.036) = 1 - 0.012 = 0.988$$

By a little ingenuity this method can be considerably extended, as illustrated by the following examples:

$$\sqrt{103} = \sqrt{100 \times 1.03} = 10 \times \sqrt{1.03} = 10 \times 1.015 = 10.15$$

$$\sqrt{408} = \sqrt{400 \times 1.02} = 20 \times 1.01 = 20.2$$

$$\sqrt[3]{8.26} = \sqrt[3]{8 \times 1.0325} = 2 \times 1.0108 = 2.0216$$

Multiplication and Division of Numbers Close to Unity

A somewhat similar method can be used for multiplying and dividing numbers close to unity. For example,

$$1.012 \times 1.015 = 1.027$$

and

$$1.007 \times 1.014 \times 1.023 = 1.044$$

This might be reduced to the formula, $(1 + a) \times (1 + b) \times (1 + c)$ etc. $= 1 + a + b + c$, etc.

Where a, b and c are very small fractions of 1.

If some of the numbers are smaller than unity the principle is the same. For example,

$$0.993 \times 1.014 = 1 - 0.007 + 0.014 = 1.007$$

The minus sign before the 0.007 indicates that 0.993 is 0.007 *less* than unity.

As another example,

$$0.987 \times 0.992 = 1 - 0.013 - 0.008 = 1 - 0.021 = 0.979$$

Division is exactly like multiplication except that subtraction replaces addition. For example:

$$1.025 \div 1.013 = 1 + 0.025 - 0.013 = 1.012$$

Again,

$$0.991 \div 0.982 = 1 - 0.009 - (-0.018) = 1.009$$

and

$$0.981 \div 1.013 = 1 - 0.019 - 0.013 = 1 - 0.032 = 0.968$$

A more complicated example involving both multiplication and division is this:

$$\frac{1.023 \times 1.014 \times 0.992}{0.997 \times 1.012 \times 1.032}$$

$$= 1 + 0.023 + 0.014 - 0.008 + 0.003 - 0.012 - 0.032 = 1 - 0.012 = 0.988$$

Another Short Cut for Square Roots

A method has been shown for getting the square root of a number close to unity. The following method can be used to get the square root of any number whether or not it is close to unity.

The first step is to estimate or "guess" the square root to one or two figures only. Call this a. Divide the number by a and get b. Average a and b. This is the first approximation to the square root. Repeat if closer approximation is desired.

Example:

$$\sqrt{590} = ?$$

Guess, $a = 7.5$

$$590 \div 7.5 = 7.86 = b$$

Average 7.5 & 7.86 = 7.68 = approximate square root.

Second approximation

$$a = 7.68$$

$$590 \div 7.68 = 7.6823$$

Average of 7.68 & 7.6823 = 7.6811

This is the correct square root of 590 to 1 part out of 500,000.

Where a slide rule is available, it can be used to read the square root correct to one part out of 500. Using the slide-rule root for the first approximation, the second, worked out as indicated, will be of high accuracy.

Refined Method of Gas Sampling and Analysis

COMBUSTION engineers who have occasion from time to time to determine with considerable accuracy the composition of gas in various parts of boiler furnaces will be interested in the apparatus and method used by the Bureau of Mines in recent boiler tests. The following is based on information contained in the Department of Mines Bulletin No. 214.

Fig. 1 shows the general arrangement for sampling furnace gases. The water-cooled sampler is placed at the desired point in the furnace and connected by rubber tubing to a steam ejector, causing a continuous stream of gas to flow through the sampler and filter. A small part of the gas stream is diverted by mercury displacement through a capillary glass tee into the gas collector. The rate of flow of mercury from the gas collector regulates the rate of sampling. A sample is generally drawn over a period of fifteen to forty-five minutes.

The water-cooled sampler is designed to permit taking true samples of the furnace gases. It consists essentially of three concentric copper tubes of 0.39-in., 0.55-in. and 0.69-in. outside

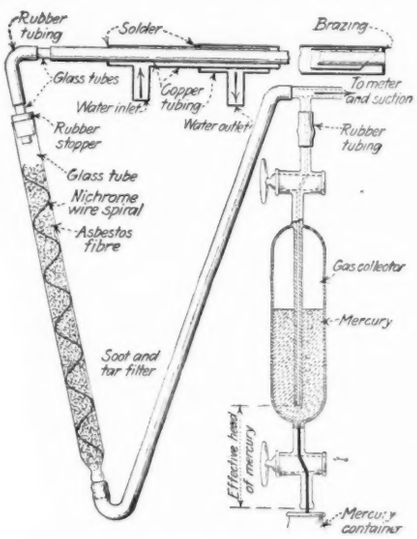


Fig. 1—Water-cooled sampler, filter and gas collector

diameter, the two outer tubes forming a double-flow water jacket. This sampler may be used at water pressures up to 40 lb. per square inch.

The gas collector has a capacity of 250 c.c. and is fitted with ground-glass stopcocks at the top and bottom. By extending the gas-inlet tube to within one inch of the bottom of the cylinder, a constant head of mercury is maintained while the sample is drawn in, the net suction head of mercury being equal to the distance from the bottom of the inlet tube to the bottom of the outlet tube. The flow of mercury from the bottle is controlled by the lower cock or by a capillary tip placed on the outlet. To prevent air from being drawn into the mercury outlet, care should be taken that the suction in the gas line does not exceed the effective head of mercury in the bottle.

For convenience in handling, gas collectors are mounted in wooden stands in sets of three, for collecting samples before, during and after the firing period.

For precise gas analysis in the field the modified Orsat shown in Fig 2 is used. This consists of a graduate burette connected through a mercury manometer to a compensating tube of equal volume (both placed in the water jacket), four pipettes for the absorption of the gases, and one combustion pipette. The gas is measured against the pressure of the air in the compensating tube, and as this air is at the same temperature as the gases in

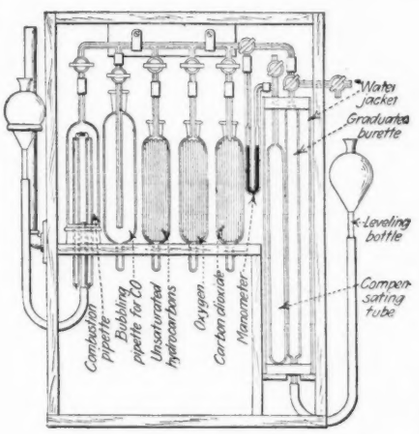


Fig. 2—Modified Orsat for precise analysis

the burette, any errors due to changes in atmospheric temperature and pressure during the course of the analysis are eliminated. The burette is connected to the absorption pipettes by a manifold of capillary glass tubing.

This apparatus differs from the ordinary Orsat in three respects—it is equipped with a compensating tube, the gases are handled over mercury, and carbon monoxide, hydrogen and methane are determined by slow combustion.

The method used for taking the sample from the gas collector into the Orsat is shown in Fig. 3. The bottom cock *A* of the gas collector is connected by a tube to an elevated mercury reservoir *B*, care being taken to exclude all air from the connection. Cock *A* is then opened, allowing the mercury to compress the gas sample in the collector, after which cock *C* is connected to the measuring burette *D* by a rubber tube from which all air is expelled by filling with mercury. As a test for leaks the leveling bottle of the burette is then lowered and all connections are subjected to a partial vacuum of about 12 in. of mercury. When all are found to be tight, *C* is opened and the sample for analysis is allowed to flow into the burette.

After measuring the total volume, carbon dioxide is determined by absorption with potassium hydroxide solution. Then oxygen is determined by absorption with alkaline pyrogallol solution. If the sample is thought to contain much carbon monoxide, this gas is next partly removed by passing it once or twice through a solution of cuprous chloride in the bubbling pipette. After the amount absorbed by the cuprous chloride has been noted, a measured amount of air is added and the sample passed into the combustion

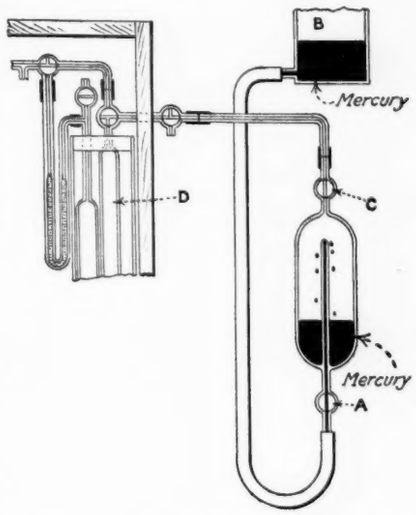


Fig. 3—Method of drawing sample into Orsat

pipette. If only a small amount of carbon monoxide is present, the preliminary absorption with cuprous chloride is omitted.

The platinum spiral in the combustion pipette is heated bright red by an electric current, and the gases are mixed by passing them in and out of the pipette several times during combustion. One minute is usually time enough to burn the combustibles. After allowing the gases to cool in the pipette, the following quantities are determined: K, the contraction on burning; CO_2, the carbon dioxide formed on burning; O_2, the residual oxygen after burning. This last figure, subtracted from the total oxygen added with the air, gives the oxygen consumed. From these quantities CO, CH_4 and H_2 are determined by the following equations:

$$H_2 = K - O_2 \text{ used};$$

$$CH_4 = \frac{2K - CO_2}{3} = H_2;$$

$$CO = CO_2 - CH_4.$$

The carbon monoxide found by the third equation is added to that determined by absorption, the sum being reported as the total carbon monoxide in the sample. If the gases are taken from a point near the fuel bed, they may be analyzed for ethylene and other unsaturated hydrocarbons by absorption with fuming sulphuric acid. The entire operation of analysis as described requires about 30 minutes.

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

II—Rules for Operating and Maintaining Boiler Appliances

Steam Pressure Gage

C-45. Compare boiler steam gages frequently. Test at times of external inspection, when the boiler is placed in service after periods of shutdown for internal inspection or repairs and after an extended period of shutdown. When the safety valve pops, note the reading of the gage and, if the reading is not in agreement with the stipulated popping pressure nor with gages on adjacent boilers operating under the same pressure, test the gage. See that the gages are tested when trouble is experienced with boiler compounds, foaming, priming, and other feed-water troubles that are apt to cause choking of the gage connections.

C-46. A steam gage is considered tested when it has been compared and made to agree with a dead-weight testing device, or a test gage which has been so tested. When compensation for waterleg has been made, make an equivalent allowance in the reading of the test gage or dead-weight testing device. Use only a reliable gage for a test gage and use it exclusively for testing gages in service.

C-47. Before testing a steam pressure gage, disconnect it at the gage union and clear the piping, cock and siphon by blowing through unless this can be done by opening a plug or valve connection. After blowing through, reconnect the gage. Do not admit steam directly into the gage and be sure at all times that the siphon is filled with water. If steam has entered the gage, it must be retested.

C-48. Keep the gages well lighted at all times and the dials and glass covers clean. See that the glass cover is maintained tight and whenever the glass is broken that it is replaced as soon as possible.

C-49. When a boiler steam gage, not in use, is likely to be subjected to freezing temperatures, drain the connections and gage.

Water Glass

C-50. Keep the communications and valves between the boiler and the water column and water glass free and clear and test by blowing down the water column and water glass, noting the promptness of the return of the water to the water column and glass, and trying the gage cocks until sure of the water level.

C-51. All water columns and water glasses shall be tested by the water tender or operator directly responsible for the level of the water in the boiler, at the beginning of each shift and preferably before the relieved shift has gone off duty.

By shift is meant a person or group of persons who relieve a person or group of persons in rotation in standing watch or operating a steam generating plant for an allotted time. It is synonymous with *watch, vigil,* or *tour of duty.*

C-52. Test water glasses after replacing. Test all water glasses on a boiler when the boiler is placed in service, and when trouble is experienced with boiler compounds, foaming, priming, or other feed-water troubles that are apt to cause choking of the connections.

C-53. Water glasses and their connections shall be kept free from leaks and no connections allowing a flow of water or steam from the piping between the water column or water glass and the boiler shall be made, as such leaks or flow of water or steam will cause a false indication of the water level in the boiler.

C-54. The outlet end of the discharge pipes from water columns, water glasses, and gage cocks shall be kept open and in sight or hearing of operator while blowing down.

C-55. Keep water glasses well lighted and clean. When they need cleaning, replace them with clean glasses. Attempts to clean glasses in place lead to possible cracking of the glass or choking from pieces of cloth or waste.

C-56. When a water glass has broken, remove the broken pieces and slowly open the valves to blow out any remaining pieces. Before inserting the new glass, see that the drain is open and that the glass is of the exact length required and that the connections are in line. Insert the glass with packing and set up the stuffing-box nuts, taking care not to set them up too tight. Then warm the glass by opening the top valve slightly and let a small current of steam flow through the glass. Close the drain cock after the glass is sufficiently warmed, open the bottom valve slightly and when the level of the water in the glass has become stable, open the bottom valve wide and then open the top valve wide.

C-57. Unless the water glass is provided with a guard to protect the operator while replacing water glasses on boilers under pressure, or unless the operator wears a mask, the valves shall be operated only by remote control. A suitable water-glass guard may be made in the form of an inverted cone of No. 22 black iron wire screen of ¼-in. mesh.

Feed-Water Regulators

C-58. If feed-water regulators are used, see that they are maintained in good working condition, but do not place complete dependence on the regulators to maintain the proper level of water in the boiler.

Fusible Plugs

C-59. If fusible plugs are used, see that they are kept in good condition and that they are not used for more than one year as provided for in Par. A-19 of the Power Boiler Section of the Code. When the boiler is open, scrape clean and bright the exposed surfaces of the fusible metal as well as the surface of the boiler near the plugs. If the fusible metal does not appear sound, renew the plug. Never refill a plug with anything but new metal of a quality specified in Par. A-19 of the Power Boiler Section of the Code.

Safety Valves

C-60. Keep all safety valves free and in working order.

C-61. Test the valves in accordance with the instructions given for the particular plant. Test the safety valves by gently raising the valve off the seat by hand or, when practicable, test the valves daily by raising the steam pressure to the popping pressure of the safety valve. Small chains or wires attached to the levers of pop safety valves and extended over pulleys to other parts of the boiler room may be used. If the valve sticks, do not try to release it by hammering; drop the pressure in the boiler and clean the valve seat or correct any other defect that may be found. When an additional safety valve is installed on a boiler in excess of the capacity required by the Rules for the Construction of Power Boilers and the capacity of that valve is equal to the capacity of the faulty safety valve, the boiler may remain in operation until it can be conveniently taken out of service.

C-62. Do not try to stop leakage by tightening the spring or by blocking it in any manner whatsoever. When a safety valve leaks at a pressure less than that at which it is set to close, repair or replace it as soon as practicable.

C-63. Whenever the safety valve pops, observe the pressure indicated by the boiler gage and, if the noted pressure varies more than 5 lb. from the stipulated popping pressure, test the gage. If the gage is found correct, adjust the safety valve. Where the working pressure is in excess of 250 lb. per sq.in., the allowable variation shall

*The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee. On account of the length of the rules *Power* is printing them in short installments, of which this is the third.

be 2 per cent of the working pressure.

C-64. Do not allow the setting or adjustment of safety valves by anyone but a competent person. Any setting or adjusting of the blowback ring or any device to regulate this feature, shall be done only by a competent mechanic familiar with the construction and operation of safety valves. Test the safety valve after any setting or adjusting of the spring or blowback ring. Do not have the water in the boiler above the highest gage cock when setting or adjusting the valve. When the spring becomes weak and must be screwed down to secure the stipulated popping pressure, make sure that the spring is not screwed down so far that there is a restriction of the proper amount of the opening of the valve as required in Pars. P-282 and P-284 of the Power Boiler Section of the Code.

C-65. Safety valves shall not be opened to reduce steam pressure in the case of low water.

C-66. Never set the popping point of a safety valve above the pressure authorized for the boiler. When there is more than one safety valve on a boiler, the setting of the popping point of the safety valves shall be in accordance with Par. P-271 of the Power Boiler Section of the Code. If the popping pressure of a safety valve is to be more than 10 per cent above or below the pressure for which the spring is designed, replace the spring with another spring designed for the proper pressure.

C-67. Where boilers are connected into a common steam header and operate under the same working pressure and some of the boilers have allowable working pressures greater than others, never set a safety valve to pop at a pressure greater than that allowed on the weakest boiler unless the lower-pressure boilers are equipped with non-return check valves and sufficient safety-valve capacity is added to the lower-pressure boilers or to the low-pressure header to take care of the capacity of the higher-pressure boilers.

C-68. Care shall be exercised to prevent the accumulation of scale, dirt or other foreign matter from collecting between the coils of the spring of the safety valve.

C-69. Keep the drain in the escape pipe open. If the safety valve pops when the operator is in a favorable position, he should observe the drain in the escape pipe in order to determine that the drain is unobstructed. When running a wire in the drain hole in the escape pipe to ascertain if it is clear, be careful that the wire does not move scale that may fall over the drain opening when the wire is removed.

C-70. Maintain the proper tension on all supports and anchors to which the escape pipe is attached and examine them at least every six months.

C-71. When making a hydrostatic test, remove the safety valves and blank the opening or clamp the valve disk securely to the seat. Also remove the water column floats, if necessary. Make sure that the safety valve is placed in good working condition after the hydrostatic test has been made.

Blowoff Equipment.

C-72. Maintain blowoff valves and cocks in good working condition and repair leaking blowoff valves as soon as practicable. See that they are in good working condition before putting a boiler in service and examine them periodically, when boiler is washed out and at times of internal inspection. Maintain in good condition the pipe and fittings between the blowoff valve and the boiler together with their insulation and inspect them periodically, at times of internal inspection and particularly when the boiler is washed out. If the discharge end of the blowoff line is visible, watch it for the purpose of detecting leaky blowoff valves.

C-73. Open and close blowoff valves or cocks carefully and slowly, and in closing the blowoff valve see that it is closed tight.

C-74. Where a large amount of blowing down is necessary, open one valve wide and the second valve until it is half open and leave it in that position until the water is lowered about ½ in. in the water glass; then open the second valve wide until the blowing down is completed.

C-75. When an operator is blowing down a boiler and cannot see the water glass, station another operator to watch the water glass and to signal the operator blowing down the boiler. Never permit one operator to blow down more than one boiler at a time and, when a boiler to be emptied is set in a battery of two or more boilers, make sure that the blowoff valves opened are on the boiler to be emptied. When blowing down a boiler do not fail to give entire attention to that duty, and perform no other duty until the blowoff valves have been closed.

C-76. Study carefully the conditions of the particular plant in order to determine the amount and frequency of blowing down; determine it by chemical analysis if possible. The amount and frequency of blowing down depends upon the number of hours a day that the boiler is in service, the rate at which it operates, and the kind of feedwater used (see Pars. C-202 to C-209). Except where the amount and frequency of blowing down are determined by chemical analysis, blow down at least one full opening and closing of the blowoff valve every 24 hours.

C-77. Blow down the boiler, if necessary, just before cutting in. When a boiler is in service, see that the blowing down is done at a time when the generation of steam is lowest. If any unusual or serious foaming occurs, check the fuel and air supply and close the steam outlet long enough to determine the true level of the water in the water glass. If the level of the water in the glass is sufficiently high alternately blow down some of the water in the boiler and feed in fresh water several times. Use surface blow-off if installed. If the foaming does not then stop, bank the fire and continue the alternate blowing down and feeding.

C-78. Allow the setting to cool slowly, particularly where there is much sediment in the boiler. After the setting has been cooled and there is no pressure on the boiler, open the vent and empty the boiler. When it is not practicable to empty a boiler at atmospheric pressure, blow it down at as low a pressure as is consistent with operating conditions. When the boiler to be emptied is set in a battery of two or more boilers, make sure that the blowoff valves that are opened are on the boiler that is to be emptied. As soon as the boiler is emptied, close the blowoff valves, remove the manhole plates, and, when necessary, the covers of other openings.

C-79. Before entering the drums or shell of a boiler, see that the blowoff valves, the main stop valve, the feedwater valves, and other valves are closed. Use some reliable method of safeguarding any one entering the shell or drum.

It is recommended that when the blowoff valves of a boiler being cleaned are connected into a common header, the blowoff valves of all other boilers be properly safeguarded against opening into the boiler being cleaned.

When electric extension cords are used when entering a boiler, the cord should not only be well insulated but designed to withstand mechanical injury and maintained in good condition. The lamps should be provided with suitable guards.

C-80. Use hose with considerable force or hand tools if necessary, to remove scale. Disconnect the blowoff line close to the boiler and run the water to waste, or when practical provide a screen which can be inserted in the blowoff hole. Wash the tubes of horizontal-return tubular boilers from below as well as from above.

See that the water does not come in contact with the brickwork of the combustion chamber, or if this cannot be avoided, see that the brickwork is dried out carefully when firing up.

Dampers

C-81. Maintain all dampers in good working order and inspect them before starting a boiler, periodically when boiler is in service, and at times of internal inspection.

C-82. If damper regulators or draft-control devices are used, see that they are kept in good working condition and inspected before starting a boiler, periodically when boiler is in service, and at times of internal and external inspections. Be alert to detect any unusual conditions which may affect the safety of the structure. Such devices do not relieve the operator of responsibility.

C-83. If coal is used as fuel, cover the grate with a thin layer of coal and start a light fire with live coals from adjacent boilers, with wood, or other light combustibles. Do not use any combustibles for igniting a coal fire in such a manner as to cause excessive smoke or possible flareback. Where pulverized coal, gas, or oil is used as fuel, make sure that outlet damper is open to create a light draft before introducing and igniting fuel.

C-84.—Under normal operation avoid an excessive amount of air but do not decrease the air to a condition that will cause a dangerous amount of incomplete combustion or objectionable pressure in the combustion chamber. In the case of fluid fuels, when increasing or decreasing the rate of firing, increase the air supply before increasing the fuel supply and decrease the fuel supply before decreasing the air supply.

C-85. Avoid excessive draft or pressure while cleaning fires.

Banking Fires

C-86. When fires are banked and the furnace temperature is reduced, make sure that enough air is carried through the furnace and boiler to prevent the accumulation of combustible gases within the setting.

C-87. When the level of the water is not visible in the water glass, try the gage cocks to determine whether the level of the water is above or below the water glass. If the water level is below the water glass, stop the supply of air and fuel and close the dampers and ashpit doors unless you are in touch with the entire situation as to boiler feed-water supply and positively certain that it is safer to continue steaming the boiler than to reduce the steaming rate. If found advisable not to stop the steaming rate of the boiler, determine the cause and remedy it immediately. If found advisable to stop the supply of fuel and air, do not change the feed-water supply, open the safety valves or change the steam outlet valves, or make any adjustment that will cause a sudden change in the stresses acting on the boiler. In the case of hand-fired boilers, do not disturb the fire except to cover it with green coal or wet ashes; where stokers are used, stop the fuel feed and open the firedoors. After the fire is banked or out, close the feedwater valves. When the boiler is sufficiently cooled, close the fire-doors and cut the boiler off the line. Determine the cause and remedy it before the boiler is again placed in service. Also examine the boiler for overheating.

C-88. In case of tube failure shut off air supply, keep outlet damper open, check fire and shut boiler stop valve. Maintain the feed-water supply if possible to do so, without drawing too heavily upon the supply to other boilers. Shut off the feed-water supply when the brickwork has cooled sufficiently to prevent injury to the boilers by overheating.

C-89. In the event of flareback or the snapping out of burners where oil or gas is used, shut off the fuel supply and thoroughly ventilate the boiler before resuming firing.

C-90. Keep the draft on while blowing soot from the tubes.

C-91. When cutting out a boiler, stop the supply of fuel, burn out the fuel in the furnace, and adjust the dampers to cool off the setting and boiler as slowly as is consistent with operating conditions. When possible, dust off tubes before fire has died out.

Production of coal from the public lands of the United States in 1924 was 1,495,026 tons, according to the Interior Department. Output of coal in 1924 from public lands by states was as follows: Colorado, 275,040 tons; Montana, 36,847 tons; New Mexico, 21,013 tons; North Dakota, 152,650 tons; Oregon, 270 tons; South Dakota, 554 tons; Utah, 181,015 tons; Washington, 35,722 tons; Wyoming, 791,911 tons. Records of the Interior Department also show that 1,100,000 tons from restricted and segregated Indian lands was produced in Oklahoma, which was more than 39 per cent of all coal produced in that state.

Mechanical Reliability of Hydro-Electric Units

Several years ago the Prime-Movers Committee of the National Electric Light Association began a study of the reliability and operating records of large steam turbo-generators and submitted results in several of its annual reports. The study culminated in the serial report of the Turbines Subcommittee, Prime-Movers Committee, Technical National Section, dated June, 1924 (N.E.L.A. Publication No. 24-57), giving the 1923 records of 106 turbines.

The Hydraulic Power Committee of the Pennsylvania Electric Association conceived the idea of making a similar study of the performance of hydro-electric units, but as the subject was too large for a geographic division to handle and was considered national in scope, the national committee, at the suggestion of the Pennsylvania committee, sponsored the study and undertook to make it nationwide.

In making up the questionnaire to be submitted to member companies, the subcommittee followed rather closely the plan and terminology used by the Prime-Movers Committee, although it was realized that some of the factors have a different significance in the case of hydro units.

The committee realized from the start that many companies would not be in a position to submit all the data asked for this year, but might revise or supplement their operating records in order to compile the data for 1925. The Prime-Movers Committee had the same experience. It was not expected that a complete report could be made at the 1925 convention. However, the results that have come in are of such interest that it is considered worth while to present them as a progress report, which it is hoped will prove to be an incentive to other companies to prepare such data.

Definitions

The terminology used is as follows:

"Service Time" is time the unit actually operated on the bus.

"Idle Time" is time the unit was not on the bus for any reason. It included both "Outage" and "Reserve" time.

"Outage Time" is time the unit was out of service or not available for service on account of hydraulic, mechanical or electrical trouble, maintenance, cleaning and inspection. The committee considers this to be much the most important information.

"Reserve Time" is time the unit was idle but available for immediate starting.

"Demand Time" is time during which the unit should have been operated for best efficiency or station load needs whether or not it actually was in service. This classification was included in order to arrive at the "Service-Demand Availability Factor" for comparison with steam units. In the case of a modern unit in a base-load station it is easy to say whether or not a unit is in "demand," but in other cases, such as a "run-of-river" plant developed to several times the minimum stream flow and operating in parallel with steam stations, it is almost impossible to say under some circumstances whether or not a unit was in demand. It is hoped that this difficulty will not deter member companies from submitting the other more important data.

"Capacity Factor" is the average output during the entire year or record period, divided by capacity. This factor has relatively little to do with reliability. Rather it is an indication of the type of service demanded of the unit or the station, the condition of the water supply, etc. A unit in a uniform-flow or base-load plant would naturally have a high capacity factor, whereas a unit with perfect reliability in an over-developed run-of-river plant might have a low capacity factor.

"Output Factor" is the average output during the time of operation or service time, divided by capacity. If this factor is low it means that the unit operates at an average output considerably less than the capacity.

"Service-Demand Availability Factor" is the "Service Time," divided by the "Demand Time." It is a measure of the availability of the unit during the time in which it was needed. The fact that it is sometimes 100 per cent means that all maintenance and inspection work on the unit could be done when it was not in demand.

In the Table a comparison is presented between the operating results of 21 hydro-electric units operating in Western plants and the 1923 records of steam units given on page 11 of the 1923-24 serial report of the Prime Movers Committee on "Turbines." In studying the results of the hydro-electric units, it should be borne in mind that they represent a comparatively small number of machines in one part of the country, nevertheless the operating records are encouraging. The

COMPARISON OF OPERATING RECORDS OF HYDRO AND STEAM UNITS

	21 Hydro Units 1924 Per Cent	87 Steam Units 1923 Per Cent
Service time	71.5	72.4
Idle time	28.5	27.6
Outage time	2.3	12.9
Reserve time	26.2	14.7
Demand time	71.75	78.4
Maximum possible service time (Service plus reserve)	97.7	87.1
Capacity factor	42.3	51.6
Output factor	59.3	71.3
Service demand availability factor	99.7	92.3

Prime Movers report covered units of 18,000-kw. capacity and larger, while the hydro units in this report are all larger than 5,000 hp. and have an average capacity of 13,170 horsepower.

Attention is called especially to the hydro "Outage Time" of 2.3 per cent and the "Service-Demand Availability Factor" of 99.7 per cent. Analysis of the "Outage Time" as to causes is not yet in shape for presentation.

It is hoped by the committee that in another year results may be presented for a larger group of hydro units representative of the entire country.

A strip of steel or iron (bar, rod, shaft or pipe) 100 feet long will expand or contract about three-quarters of an inch for each 100 deg. F. change in temperature.

Recent Publications

The Testing of High-Speed Internal-Combustion Engines. By Arthur W. Judge. Published by D. Van Nostrand Co., New York City. Cloth; 6x9 in.; 384 pages; 242 illustrations; numerous tables. Price, $7.50.

There has been so much material appearing in the technical press on the results of high-speed engine tests that it has been difficult for engineers to find the filing space for the clippings. The author of this volume has gathered this material and by the process of elimination and condensation has produced a most readable volume. Not only are data given on tests run by various authorities, but in addition the entire procedure necessary in the testing of any engine is carefully outlined. It is one of the notable books on internal-combustion engines published in recent years.

Coke as a Household Fuel in Central Canada, by J. L. Landt, consulting engineer. Published by the Dominion Fuel Board in co-operation with the Mines Branch, Department of Mines by F. A. Acland, Ottawa, Canada, with the authority of Hon. Charles Stewart, Department of the Interior and Mines.

In searching for a substitute for anthracite for the "acute fuel area" of Canada, an investigation was made as to the feasibility of establishing coke industries at various points in the area affected. The results of this investigation are recorded in this book by Mr. Landt. The thorough study with facts clearly stated is enlivened by pictures, charts and tables, the frontispiece being "A Coal Products Tree." Markets, systems, plants, byproducts, duty, transmission and rates are gone into at some length. The anthracite and bituminous coal fields of the United States as well as the amounts of coal exported from them to Canada for six years are included.

Proceedings of the 27th Annual Meeting of the American Society for Testing Materials. Published by the A.S.T.M., 1315 Spruce St., Philadelphia, 1924. Paper; 2 vols; 6x9 in. Total, 2,296 pages.

Vol. 1 contains committee reports and new and revised tentative standards, while Vol. 2 is devoted to technical papers. The A.S.T.M. properly exerts an immense influence in the fixing of standards, and these volumes are particularly valuable for this purpose. Following a general outline of the meeting are the reports of many committees, including those on steel, the effect of sulphur on rivet steel, the effect of sulphur on structural steel, wrought iron, cast iron, heat treatment of iron and steel, corrosion of iron and steel, magnetic properties, magnetic analysis, ferro-alloy, corrosion of nonferrous metals and alloys, cement, standard specifications for concrete, reinforced concrete, preservative coatings, petroleum products and lubricants, coal and coke, waterproofing material, electrical insulating materials and thermometers. The remainder of the first volume is given over to the A.S.T.M. tentative standards submitted or revised at the meeting. These cover a wide range. Among the papers in Vol. 2 of possible interest to power-plant men are those in the symposium on the effect of temperature upon the properties of metal, four papers on the fatigue of metals and papers on the testing of corrosion. The book is an object lesson of what can be done by a large number of small committees of specialists, each assigned a definite task.

House Heating with Oil Fuel. Compiled by P. E. Fansler, associate editor of *The Heating and Ventilating Magazine*. Published by the Heating & Ventilating Magazine Co., 1123 Broadway, New York City. Paper; 8x10½ in.; 63 pages; illustrated. Price, $1.

This compilation covers the subject of house heating by oil from all angles. It discusses the desirability, combustion, the conditions necessary in an installation, efficiency, burners, etc., and includes "Oil Burners as Listed by the Underwriters' Laboratory," complete to March 20, 1925.

Fundamental Principles of Generators and Motors; Examples. By Prof. F. E. Austin. Published by the author, Hanover, N. H., 1924. Cloth; 5x7½ in.; 108 pages; 48 illustrations; 8 tables. Price, $2.50.

In this book are given a large number of problems dealing with direct-current generator and motor design and operation. Many of the problems are worked out to show the procedure to follow in applying fundamental principles. The nature of the book makes it necessary that a large part of the treatment be mathematical rather than practical. Students that are fairly well versed in mathematics may find this little book of interest.

Transmission Towers. Published by the American Bridge Co., Pittsburgh, Pa., 1925. Flexible binding; 6x9 in., 181 pages; 29 tables; 118 illustrations and charts.

Although this book is put out as representing one manufacturer's product, it may be correctly called a work on the design and construction of steel towers, poles and other steel structures used in the development and transmission of electric power, rather than a catalog. The only thing about the book that gives it the appearance of a catalog is the manufacturer's name on the cover and title page; the text is devoted entirely to the problems involved in the use of steel towers and poles for transmission of electric power. All those interested in transmission-tower problems will find this book a valuable adjunct to their technical library.

Entropie des Wasserdampfes in elementarer Ableitung (Entropy of Steam in Elementary Presentation). By Fritz Bürk. Published by Otto Spamer, Leipzig, Germany, 1924. Paper; 6x8 in.; 47 pages. Price, bound in paper, 2 gold marks; bound in cloth, 2.60 gold marks.

This booklet is an attempt to meet the world-wide demand for an explanation of entropy that will be comprehensible to the average engineer of moderate education. It appears that the writer does make some contribution to the presentation of this subject. However, as a knowledge both of German and of elementary calculus is necessary to understand the booklet, it is to be expected that its contents will be unavailable to the average American engineer who has been perplexed by entropy.

The Mechanism for the Graphitization of White Cast Iron and Its Application to the Malleableization Process. Bulletin 71. By Anson Hayes and W. J. Diederichs. An investigation conducted by the Iowa Engineering Experiment Station and the Department of Chemistry of Iowa State College. Published by Iowa State College of Agriculture and Mechanic Arts Official Publication, Ames, Iowa.

This 45-page bulletin describes the sixth step in an investigation of the mechanism by which white cast iron may be graphitized, or changed to malleable iron, reports of other steps being previously published as completed. No report of a scientific investigation into the process of making black-heart malleable from white iron appeared until 1902. On account of secrecy surrounding the business until 1910, little knowledge was disseminated. Numerous papers were then submitted to the technical press. The work leading up to evolving a theory of complete graphitization of white iron and its application to commercial annealing is here described. The reasons why some temperatures in heating or cooling are most favorable to formation of the desired metal structure are carefully deduced. The text is primarily for the metallurgist.

Contributions to the History of Technology and Industry (Bertraege Zur Geschichte). Fourteenth Year Book of the V.D.I. Compiled by Conrad Matschoss. Published in German by the V.D.I., Berlin, Germany. Paper; 8x11 in.; 274 pages; 209 illustrations.

A collection of essays and biographies that link the early beginning of German industries and science with the present state of their development, the work is of historic interest to engineers and designers in reviewing the many problems that had to be solved as a basis of modern engineering achievements. The volume contains the following contributions:

1. The history of the railroad brake. 2. Frederick William, Count of Reden, mining engineer. 3. The life of Alfred Krupp. 4. The history and future of industrial and biological chemistry. 5. Bethel Henry Strousberg, pioneer railroad magnate. 6. Medieval and oriental self-releasing arrow and spear

traps. 7. The history and development of screw threads. 8. The history and future of aluminum and its alloys. 9. The construction of lifting cranes from the earliest types to the present. 10. The history of the City of Augsburg and its industries. 11. The history of iron and steel wiredrawing processes. 12. Carsten Waltjen, pioneer German shipbuilder. 13. Old oak wine presses. 14. Emil Kessler, pioneer German locomotive builder. 15. The history of the electric accumulator. 16. Brief reviews of the leaders in German iron and steel industries.

Die Kondensation bei Dampfkraftmaschinen (Condensation in steam power plants). By Dr.-Ing. K. Hoefer, head engineer of the German Lloyd, Berlin Germany. Published by Julius Springer, Berlin, 1925. Cloth; 6 x 9 in.; 443 illustrations. Price, 22.50 gold marks.

Giving the latest German theory and practice regarding condensers and condensation as related to steam power plants, this book should be of value to those American specialists in the subject who find it necessary to keep abreast of what is going on in other countries. A considerable amount of data is given, together with computations for the design of various types of condensers. Material on corrosion is included. The contents are not limited to the condenser itself, but extend to include air pumps, condensation pumps, etc., and the question of regulation and cooling towers.

Electrical Machinery Erection. By Terrell Croft. Published by McGraw-Hill Book Company, Inc., 370 Seventh Avenue., New York City. 1925. Cloth 5½x8 in.; 314 pages; 334 illustrations. Price, $3.

A great many practical ideas on the handling and erection of electrical machinery have been published, but for the most part they have appeared in technical magazines and are not readily available. What the author of this book has done, is to bring many of these ideas together in convenient form. As the title indicates the treatment is with the mechanical end of the equipment rather than the electrical. The subject matter is divided into five sections: Unloading and moving electrical machinery; supporting electrical machinery; erecting electrical machinery; locating and fixing electrical machinery; electrical-machinery mechanical maintenance.

In the first section the unloading of machinery from railway cars, its transportation by various means and correct and incorrect methods of handling are gone into. How motors are mounted on various types of foundations and on the machine they are driving, is shown in section two, also how they are supported from walls and ceiling. The placing of a motor on its foundation, or lifting it into place when it is to be mounted on the wall or ceiling, presents many problems for which solutions have been given in section three. This section also goes into the problems of erecting heavy machinery when a crane is not available and gives various methods of heating rotors before pressing them on their shaft.

An important factor in the operation of any machine is to have it properly lined up and level. A comprehensive treatment of this subject is given in section four, where 60 pages are devoted to the different methods used. In section five the problems of proper lubrication, maintenance of bearings, air-gap adjustments, balancing of armatures and motors, etc., are dealt with. The treatment throughout is from the practical man's viewpoint, and the work should find a wide field of usefulness with this class of readers as well as in industrial schools.

Roper's Questions and Answers for Steam Engineers and Electricians. Seventh edition, rewritten and enlarged by Rufus T. Strohm and James D. Purdy, assisted by F. D. Keese and A. C. Clarke. Published by David McKay, 604 South Washington Square, Philadelphia, 1925. Cloth; 4x6 in.; 352 pages. Price, $2.

This handy little book contains the answer to hundreds of simple questions relating to power-plant operation and should assist the man preparing for license examinations. First published in 1880, it has been revised from time to time. The present revision, while excellent so far as it goes, may be criticized for the lack of material on certain types of modern equipment such as the unaflow engine.

Farm Motors. By A. A. Potter, Dean Engineering Schools of Purdue University. Published by the McGraw-Hill Book Co., Inc., New York City. Cloth; 5½x8½ in.; 290 pages; 279 illustrations. Price, $2.50.

The first edition of "Farm Motors," published in 1913, was adopted by many agricultural schools as a textbook on farm engineering. In this, the third edition, some new matter has been inserted, although the volume must still be regarded as a primer on the subject. As a high school or manual training school textbook it should be excellent, as the discussions are in terms understandable to the youth and cover such motors, including steam, gasoline and electric, as are in general use on the farm.

Structural Engineers Handbook—Data for the Design and Construction of Steel Bridges and Buildings (Third edition). By Milo S. Ketchum, C.E. Dean of College of Engineering and Director of Engineering Experiment Station, University of Illinois. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1924. Flexible binding; 6 x 9 in.; 1,000 pages including 316 pages of structural tables; 450 illustrations; 265 tables. Price, $7.

The name of Ketchum has long been familiar to structural engineers, as he has acquired a unique reputation in that field where the preceding editions of this book have become standard reference work. In the power-plant field the book is of interest to those engineers concerned with structural design, of whom there are a fair number. This new edition has been revised and partly rewritten and more than 130 pages of new material have been added. Among these is material on the design of self-supporting steel stacks, standards for constant-dimension steel columns and steel column footings, specifications for structural steel and for concrete.

E M F Electrical Year Book. Edited by Frank H. Bernhard. Published by Electrical Trade Publishing Co., 1925. Cloth; 9x12 in.; 999 pages. Price, $2.

This book is a classified directory of electrical and related products, their manufacturers and trade names, with definitions of each class of products and catalogs exhibits of manufacturers. In order to keep the book to a convenient size, it has become necessary to eliminate all topics having no close relation to electrical products. In addition to this Canadian listings have been dropped. Effort has been made to include all American firms that actually manufacture under any of the nearly 3,250 classifications of products given in the directory.

Transformer Standards. A new edition of "Transformer Standards" of the Electric Power Club has just been issued, dated January, 1925. This contains all the new standards that have been adopted since the previous edition of 1924 was printed. These standards cover such subjects as ratings, performance, specifications, manufacturing practice, operation and maintenance, lead marking and connections. Copies of these standards can be obtained from the Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio. Price, 35 cents.

The Effect of Temperature upon Properties of Metals; A Symposium held at a joint meeting on May 29, 1925, at Cleveland, Ohio, of the American Society of Mechanical Engineers and the American Society for Testing Materials. Reprinted from the Transactions of the A.S.M.E. Vol. 46, 1925, and the Proceedings of the A. S. for T. M., Vol. 24, Part II, 1924. Published by the A. S. M. E., 29 West 39th St., New York City. Paper, price, $1.50.

Four Years of Labor Mobility: A Study of Labor Turnover in a Group of Selected Plants in Philadelphia, 1921-1924. By the Industrial Research Department, Wharton School of Finance and Commerce, University of Pennsylvania, by Anne Bezanson, Miriam Hussey, Joseph H. Willits and Leda F. White. Published as a Supplement of Vol. CXIX of the Annals of the American Academy of Political and Social Science, Philadelphia, May 1925.

Benjamin Garver Lamme—A Tribute, by Charles F. Scott, professor of electrical engineering, Yale University, has recently been sent to friends and associates of Mr. Lamme. The pamphlet gives in a condensed way a splendid summing up of the fine and endearing qualities, and also contains a good photo of Mr. Lamme.

Dominion Water Power and Reclamation Service, Annual Report, 1923-24, J. B. Challies, director. Published by the Department of the Interior, Canada. Copies of the report may be obtained by writing to the Director of Water Power and Reclamation, Ottawa, Canada.

Muscle Shoals Commission Adverse to Temporary Leasing of Power

Testing Period Will Be from August, 1925, to June, 1926, Giving Congress Time for Action

NO RECOMMENDATION will be made by the President's Muscle Shoals Commission for the disposal of the power that will become available at Muscle Shoals during the testing period. The commission, at a meeting in Washington, June 10, however, went emphatically on record as being opposed to any lease of power or properties prior to final action by Congress. They went further and expressed the belief that no one should be allowed to erect any structures on the site and that no outside agency should be permitted to participate in the operation of the plant.

These expressions are put forward in a letter to the Acting Secretary of War in reply to a communication he addressed to the commission on April 14. In that letter Secretary Davis asked for the views of the commission on two plans that he outlined. One was for the sale of power under a contract that would be revokable at any time by the War Department. The other provided for a revokable lease for the steam plant and the hydro power with a provision that a portion of the power be made available for use at nitrate plant No. 2, which might be leased to a third party. To these suggestions the commission replies as follows:

COMMISSION REPLIES

"After a long and careful study it is the opinion of the members of the Muscle Shoals inquiry that until Congress has taken action no lease, temporarily or otherwise, of the plants power or other properties should be made. We do not believe that any person, persons or corporations should be permitted to erect on the site any buldings or other structures or in any way participate in the operation of the plant prior to final action by Congress. We further believe that the testing out and the tuning up of all of the hydro-electric machinery and other power equipment should be carried out under the direction and the responsibility of the Chief of Engineers of the United States Army.

"As far as the disposition of any power that may result from the testing and tuning up of this plant, previous to the settlement of the matter by Congress is concerned, this inquiry does not believe that it can add in any way to whatever authority or jurisdiction the War Department may now have. We, therefore, leave this phase of the matter entirely in the hands of the War Department, reiterating our opposition to leasing or participation of others in the project."

While the letter was signed only by Chairman McKenzie, it had the approval of all members of the commission. In some respects the letter evidently was intended to round out the record, as the commission knew that developments since the Secretary's letter was written have precluded leasing of the power.

The War Department expects to test out the machinery under load and will arrange informally for compensation for such power as is fed into the interconnected system of the Southern power companies. So the commission's letter has no bearing on the immediate situation. As the testing period will extend from August until June of next year, ample opportunity will be given for Congress to act.

The discussion of the Secretary's letter and the drafting of the reply took up most of the time at the commission's second meeting, but some further allocation of work was made among the members. The work before the commission lends itself better to this type of handling, making frequent meetings unnecessary. No further meeting probably will be called for a month at least. The individual members, in addition to their studies of the various phases of the problem, now are being kept very busy going over the mass of material that has been submitted in response to the commission's call for suggestions bearing on the disposition of the Muscle Shoals properties.

Watt Engine of 1815 Still in Operation

A recent copy of *Engineering* in describing the reconstruction of the Bow power station of the Charing Cross Electricity Supply Co., Ltd., London, Eng., says: "Close by the Bow power station . . . is an old Watt engine, erected about 1815, which is still in occasional operation. Inside the power station are two splendid Sulzer engines, each coupled to a 4,000-kw. generator. These were erected near the beginning of the present century and then represented about the acme of reciprocating steam-engine practice. Today they are obsolete and utterly worthless, save for scrap, whilst, as already mentioned, the old Watt engine close by, is still doing useful work. It would be difficult to find a more striking illustration of the difference in the conditions which today confront the investor in power plant from those with which his great grandfather had to deal."

Proposed New Power Plant for Buenos Aires

The Spanish-Argentine Electricity Co., Cia. Hispano-Argentino de Electricidad, is planning to build a power station of 500,000 kw. capacity in the new port of Buenos Aires. Probably seven steam turbo-generator sets will be installed. Coal-burning boilers are to be used. The station will supply current to Buenos Aires for power and lighting purposes—Trade Commissioner G. S. Brady, *Commerce Reports*.

International Trade Convention Plans

The Twelfth National Foreign Trade Council's Convention will be held in Seattle, Wash., June 24-26. This will be the Council's first comprehensive international convention.

Delegations of business men have accepted the Council's invitation and will come to Seattle from Japan, China, India, Straits Settlements, the Dutch East Indies and the Philippines. They will take an important part in the group sessions on the practical phases of foreign trade, which will cover such vital matters as credits and credit information, selling methods, packing, shipping, documentation and finance, and advertising. As announced by the Council's headquarters at New York, group sessions will be held on American foreign trade problems in each one of these Eastern nations.

United States Exports of Leather Belting Increase

The 1925 foreign demand for American manufactured leather belting has steadily increased, from 81,446 lb. purchased in February to 151,284 lb. valued at $197,689, in April. The exports during the first four months of 1925 amounted to 430,037 lb. valued at $624,710, and represented an increase of 36.3 per cent over the quantity exported in the corresponding period of 1924.

April, 1925, exports of leather belting from the United States (151,284 lb., valued at $197,689) exceeded in quantity the belting exported during April, 1924 and 1923, respectively, by 80.6 and 53.6 per cent. Canada was the predominating market, with purchases amounting to 23,584 lb., valued at $12,258. Other excellent quantity markets were British India (19,838 lb., valued at $32,583), Chile (16,733 lb., valued at $9,293), China (16,247 lb., valued at $23,431), United Kingdom (12,863 lb., valued at $18,679), and Mexico (10,344 lb., valued at $17,636.)

Skagit River Development of Seattle System

The first section of the new power house, containing two units, which under the present head will develop 25,000 hp. each, of the Skagit River development of the Seattle Municipal Light and Power System, known as the Gorge plant, which has been under construction for the last six years, was officially placed in operation Sept. 27, 1924. Pictures of this development are shown on pages 948 and 949 of this issue.

The Skagit River itself is the largest stream tributary to Puget Sound, rising in Beaver Lake, B. C., and emptying into the Sound near Mt. Vernon, Wash. It is 125 miles long with a drainage basin of 3,100 square miles. This basin receives an annual precipitation exceeded in few areas in the United States, and having a high elevation creates a condition especially favorable for summer storage, in snow fields and glaciers.

The flow of the river at the point of diversion averages 4,650 cu.ft.-sec. With the maximum run-off occurring during the summer season, May to August, and the minimum at times of low temperature usually from the latter part of December to the first of March.

The portion of the Skagit River that is to be utilized for power, according to J. D. Ross, the superintendent of the Seattle Municipal Light and Power System, lies in a twelve-mile section about forty miles from the mouth of the river, although the dam proposed at Ruby Creek will back the water up to just over the Canadian boundary. The head available for power is 1,115 ft.

With the water available, the potential power that can be developed is 225,000 kw. continuous, or about 2,000,000,000 kw.-hr. per annum. The capacity as planned at present is 555,000 hp., which may be increased as required by the character of the load to be carried in the future and to work in conjunction with steam and other hydro developments on the same system.

The first unit of the development consists of a power house, located just above the mouth of the Newhalen Creek, contains two 30,000-kva. Westinghouse generators, each driven by a S. Morgan-Smith vertical hydraulic turbine of 38,800 hp. The power house is large enough for three of these units and the foundations, penstock and Johnson valves are placed for three units.

The machines are designed for 375 ft. head and are operated at 270 ft. at the present time or until the proposed Gorge masonry dam is built to raise the head approximately 100 ft. Water to the turbines is conducted through a tunnel 11,000 ft. long and 20 ft. 6 in. diameter lined with 18 in. of concrete.

This tunnel runs on an even grade from intake to power house and divides at the lower end into three 10-ft. openings that are lined with steel for the last 400 ft. and each is closed at the lower end by a Johnson valve. A surge chamber of the same diameter as the tunnel is driven vertically up through the mountain at a point 1,100 ft. from the power house.

The demand for power on the Seattle Municipal System is growing at such a rate that the present 50,000-hp. installation will be utilized in 1927 or at the latest by 1928. The original plans called for building a masonry dam at the Gorge to raise the head on the present units to 375 ft. and provide storage for daily variations in load. On account of the immense storage possible at the Ruby reservoir, which will conserve the entire river flow for power, it is now planned to build the Ruby dam as the next step of development.

A bond house has brought suit in the U. S. District Court to recover $177,425 from E. C. Storrie, principal contractor on the Skagit project. The firm has filed counter-charges alleging irregularities in awarding the George Creek tunnel contract. In denial the Storrie Co. claims that three bond houses compelled it to enter a conspiracy to obtain $2,000,000 of utility bonds of the city below par, by inducing it to raise its bids to absorb the discount and by promising the contractors concessions and rebates. The counter-charges also involve a former president of the City Council and the city's chief engineer on the project. State examiners are checking up every item of construction.

Trade Bodies Warned Against Violating Public Interest

Reports that an era of great expansion in trade-association activities is pending as a result of the Supreme Court decision clarifying the legitimate programs of such association has brought from Herbert Hoover, Secretary of Commerce, warning that the government is prepared to prosecute with the utmost vigor any association that oversteps the bounds of "public interest" by using the decision as an excuse for the restraint of business activities. So long as the associations work constructively for the good of business as a whole, Secretary Hoover will support them with the entire force of his position and his department, he indicated, according to the press.

There are about twenty activities coming within the scope of such organizations which are of unquestioned public interest, Mr. Hoover declared. Clarification of business documents, establishment of better business principles and trade ethics, recruiting and reporting of statistics are all activities making for better competitive conditions. With this broad field in which to function, Mr. Hoover believes, there is little ground for apprehension that the associations will engage in any attempt to restrain trade. Moreover, they would lose the confidence of the government and the public, and the movement as a whole would be greatly injured.

So-called "open price associations" are not looked upon with approval by Mr. Hoover, it was indicated, nor does he believe that they are in the public interest, although their legality is a moot point. These associations function somewhat as legitimate trade associations, except that they are concerned primarily with statistics on prices rather than on production and distribution. They do not necessarily imply restraint of trade, but may easily be the basis for such restraint through price agreement, it was stated.

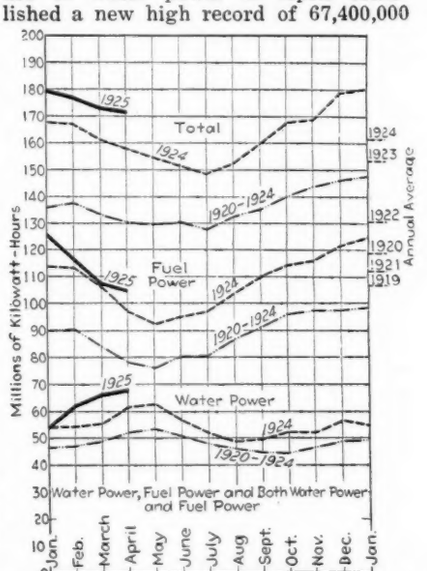
Louisville's New Turbine Started

The Louisville, Ky., Gas & Electric Co. recently placed in operation the new 27,000-kw. steam turbine in its Waterside plant. The new unit brings the installed capacity of the plant up to 94,000 kw. making this the largest plant in Kentucky. Plans are being made to supplement its present capacity with hydro plants at the falls of the Ohio River and at Green River.

Production of Electricity by Water Power Increases

The average daily production of electricity by public-utility power plants in April was 172,000,000 kw.-hr. per day, less than 1 per cent smaller than the average output for March.

The production of electricity by the use of water power in April established a new high record of 67,400,000 kw.-hr. per day. This is 39.2 per cent of the total output.



Note: *Average daily production is obtained by dividing the total for the month by the number of days in the month*

Central Stations, Electric Railway Plants, and output of other Plants Generating Electricity for Public use

The average daily production of electricity for each month in this year by public-utility power plants and the proportion produced by water power were as follows: January, 179,700,000 kw.-hr. —31 per cent; February, 177,900,000 kw.-hr.—35 per cent; March 173,000,000 kw.-hr.—38 per cent; and April, 172,000,000 kw.-hr.—39 per cent.

Chicago Sanitary District Denied a Rehearing

A motion to rehear the Chicago diversion case was denied by the United States Supreme Court June 8, at its last session of the term. The motion was filed June 1, by attorneys for the Chicago Sanitary District, see *Power*, June 9, page 928, who declared in their supporting brief that the Court, in its decision affirming the injunction granted the federal government against diversion of 10,000 cu.ft.-sec. of water from Lake Michigan, had misinterpreted several points in the evidence in the case. Denial of the motion for a rehearing finally disposes of the case.

Feather River Hydro-Plant Plans Progressing

Preparatory to starting construction on a large hydro-electric development on the Feather River, the Feather River Power Co. has purchased 2,500 acres of land in Plumas County, Calif. A dam is to be built on Bucks Creek which will store 110,000 acre-ft. of water. The first of six plants to be built will develop 50,000 hp. under a head of 2,400 ft., and will cost approximately $8,500,000.

Work on the dam will begin with little delay, it is announced. Officials of the company met June 3, with directors of the Honcut-Yuba Irrigation district, with whom a tentative contract for supplying water has been made.

Virginia Railway & Power Co. Sold to Syndicate

Negotiations were successfully completed recently for the sale by Frank J. Gould of his control in the Virginia Railway & Power Co. to a syndicate consisting of Stone & Webster, Inc., Chase Securities Corp., Blair Company, Inc., and Blodget & Co. This syndicate has also acquired control of several other Virginia properties.

The property of the Virginia Railway & Power Co. includes extensive holdings in the Roanoke and Rapidian Valleys, containing valuable water-power sites, and it supplies light, power and street-railway service to Richmond, Norfolk, Petersburg, Portsmouth and other communities as well as doing the entire gas business of Norfolk. The plant and property are valued around $50,000,000 and the total assets around $60,000,000. The electric equipment consists of five generating stations of 140,000 hp. capacity, including both steam and hydro units. The purchase includes the Spotsylvania Power Co., which serves Fredericksburg, and which owns water-power sites on the Rappahannock River.

Ford's "East Indian" To Be Equipped with Diesels

The Ford Motor Co. is having the Sun Shipbuilding Co. convert to Diesel propulsion another of the Shipping Board's steam propelled boats—the "East Indian," for transporting Ford automobiles overseas. The "East Indian" was built in Uraga, Japan, in 1918, is 445 ft. long, with a gross tonnage of over 8,000.

The propelling units will consist of two sets of Sun-Doxford opposed-piston solid-injection engines, each having 4 cylinders, 21¼-in. bore, and a combined stroke of the opposing pistons of 85 in. These engines, when turning at 85 r.p.m., will develop 2,500 brake horsepower.

There will also be installed two 225-hp. Worthington Diesel engines of the two-cycle solid-injection type, direct-connected to electric generators. A part of the power derived from these machines will be used to run three-stage air compressors supplying air to be used in maneuvering the ship, and will also supply power for operation of all electricity driven auxiliary equipment on the vessel.

Coal May Now Be Purchased Through Mail Order House

Sears, Roebuck & Co., the Chicago mail order house, has decided to go into the soft-coal business, according to the press, and will offer coal direct from mines in southern Illinois, southern Indiana and western Kentucky, in carload lots to individuals, companies or club groups. This new method of selling coal, President Kittle pointed out, eliminates middlemen, jobbers, agents and salesmen, and makes it possible to buy coal at mine prices at a saving of $1 to $3 a ton.

"When the coal is shipped we send a bill to the nearest bank and a copy to the purchaser," said Mr. Kittle. "All the consumer has to do is to pay the bill at the bank. Then an order is issued on the railroad to deliver the coal. Freight charges are paid to the agent. We are looking forward with keen interest to the season's results in a great merchandising experiment designed to cut down distribution costs on one of the great basic necessities."

Bureau of Mines Transfer to Assist in Grouping Agencies for Research in Aid of Industry

Change Recommended by Joint Congressional Committee as Part of Reorganization Program

ON JUNE 4 the President, by executive order, transferred the Bureau of Mines from the Department of the Interior to the Commerce Department. The change is one of those recommended by the Joint Congressional Committee.

Secretary Hoover of the Commerce Department immediately announced that no policies would be formulated until there has been full discussion with the organizations representative of the industry, as well as with mine labor and others interested in the safety work of the Bureau.

Secretary Work, of the Interior Department, in announcing the transfer to the press, gave a few of the reasons for the transfer, which are in part as follows:

"Its (Bureau of Mines) transfer with the Division of Mineral Statistics from the Department of the Interior to the Department of Commerce has been resolved upon as part of the program of better grouping of federal functions, according to that major purpose, it being proposed to create in the Department of Commerce a division embracing the activities of the government's scientific and economic research in aid of industry.

"The primary objects of such segregation are of course to secure economy in administration and more efficient relationship with the public. As instances of the large areas of overlap between the Department of Commerce and Interior in these functions, the following may be cited:

"Our investigations show that the laboratories of the Department of Commerce carry on scientific research in the use of gasoline and lubricating oils in gas engines, while the Bureau of Mines carried on research generally into gasoline and petroleum products. The Department of Commerce laboratories carry on investigation into the qualities of fuel, whereas the Bureau of Mines laboratories tested fuel as to its qualities. The Department of Commerce contains a division for service in domestic distribution and foreign trade in mineral products, the Bureau of Mines carried on work of economic character of much the same implication. The Department of Commerce provides statistics of mineral production every ten years—in some cases every two years—whereas the Department of the Interior provides statistics of mineral production every year and in many cases every month. The Department of Commerce maintains economic research in use of raw materials for manufacture—a large portion of which are minerals, while the Bureau of Mines investigates the production of raw materials for manufacturing purposes."

Hoover Expresses Regret at Loss of Bain

Secretary Hoover gave public expression to the regret he feels that Mr. Bain is leaving the bureau. He pointed out that Mr. Bain has been one of his close personal friends for thirty years and characterized him as one of the outstanding men connected with the industry. He also called attention to the fact that Mr. Bain is leaving to undertake work for which he is particularly fitted and for which he will receive a much higher salary than he could hope to secure from the government.

The Bureau of Mines will continue to occupy its present quarters in the Interior Building. As some time is certain to elapse before the new director will be chosen, Dorsey Lyon has been recalled from the West to take up again the duties of that office. Owing to the extended absences of Director Bain in the dispatch of foreign assignments Mr. Lyon has served as acting director for a considerable portion of the time during the last two years. It is understood that he is in no sense a candidate for the vacancy. He is much more interested in the metallurgical side of the bureau's work, of which he has been in charge for a number of years.

Large Power Project for Spain Under Way

After a long technical examination an engineers' commission has chosen the small town of Mequinenza on the River Ebro for the site of the construction of a gigantic artificial waterfall which will supply electric power to the northeastern provinces of Spain. The big artificial lake will also be used for an irrigation system in these districts. The ambitious project was originally planned and financed by the Canadian banker Mr. Pearson, who perished on the "Lusitania."

The work will be undertaken by the Compania de Riegos y Fuerze del Ebro, which has headquarters in Barcelona. The plan entails the destruction of entire villages situated in the provinces of Lerida, Zaragoza and Huesco. The two hitherto practically barren provinces of Aragon and Catalonia will benefit principally from the scheme and are expected to become richly productive agriculturally.

Statistical Information Now Difficult To Obtain

Since the war the government bureaus have been having a much smaller percentage of returns on all questionnaires. This is recognized as being the natural reaction from the flood of questionnaires sent out during the war. More recently, however, a decided disinclination to submit figures has developed. The Bureau of the Census, which depends to a considerable extent on voluntary figures, is finding it much more difficult to secure a sufficient percentage of returns to give accurate ideas of trends.

Most government agencies engaged in statistical activities find it more satisfactory to get figures on a voluntary basis, and they fear that the refusal or indifference of industry in complying with these requests will result in legislation increasing the scope of the returns that now are compulsory.

Western Engineers Hold Annual Meeting

On the evening of June 3 at the Hotel LaSalle, Chicago, the Western Society of Engineers held its 55th annual dinner meeting. Regardless of the excessive temperature an attendance approximating 160 participated in a most successful event. The retiring president, Elmer T. Howson, reviewed the early days of the society and summarized briefly the proceedings of this year of office. It is of interest to note that a net increase of 144 brought the total membership to 2,478 and that the attendance at the weekly meetings of the society averaged 177.

Announcement of the officers for the ensuing year read as follows: Homer E. Niesz, president; F. E. Morrow, first vice-president; Maj. Rufus W. Putnam, second vice-president; John A. Garcia, third vice-president; George W. Hand, treasurer; Frank D. Chase, M. M. Fowler and F. F. Couley, trustees.

A response by the newly elected president, Homer E. Niesz, was followed by the presentation of the Washington Award to Jonas Waldo Smith, C. E., D. Eng., for pre-eminent services in promoting the public welfare.

Presentation of the Chanute Medals for the three best papers read in 1924 were to Paul L. Battey, on "The Maintenance Requirements for the Mechanical Equipment of a Railroad"; Walter A. Shaw, "Shall Public Service Be Rendered by Regulated Monopolies" and to the late Prof. J. H. Hayford, on "The Establishment of Isostasy."

Entertainment and an address by the Hon. James H. Wilkerson, U. S. District Judge, on "The Civic Responsibilities of the Professional Man," were the closing events of the evening program.

Fuller-Lehigh Co. Makes Further Expansion

Information has just been received to the effect that the Fuller-Lehigh Co., the oldest manufacturer of pulverized-coal equipment, has bought out the entire pulverized-coal business of the Bonnot Co., of Canton, Ohio, which includes all rights to the manufacture of the Bonnot unit-air pulverizer.

This acquisition gives the company a complete line of equipment, as it is now in a position to furnish not only its standard storage bin and feeder system, but also unit mills of both the high-speed impact type and the slow-speed ball type.

It will be recalled that about two years ago the Fuller-Lehigh Co. absorbed the business of the Quigley Fuel Systems, Inc.

Personal Mention

James Hartness, president of the American Engineering Council, is gradually recovering from an operation which he underwent some months ago.

Carl M. Vail has recently become vice-president of Abbott, Merkt & Co., Inc., industrial engineers and constructors, at 175 Fifth Ave., New York City.

L. R. Meisenhelter, of Philadelphia, will take charge of the assembling of the machinery, transportation and manufacturing exhibits at the Sesqui-Centennial celebration in Philadelphia next year.

Porter J. McCumber, formerly Republican Senator from North Dakota, has been appointed to the International Joint Commission by President Coolidge. Mr. McCumber succeeds Charles E. Townsend, formerly Senator from Michigan.

Daniel H. Braymer has resigned as editorial director of *Industrial Engineer*, the Chicago publication of the McGraw-Hill Co., Inc., to devote the major part of his time to the activities of the recently organized D. H. Braymer Equipment Co., Omaha, Neb. He will retain his connection with the publication in the capacity of consulting editor.

Obituary

Judson Pratt, chairman of the life and accident insurance department of the N.A.S.E., with which he was affiliated for many years, and widely known authority in the oil and engineering circles of Cincinnati, died, following an illness of several months, on May 27. He was sixty-eight years old and went to Cincinnati forty-one years ago as manager of the Valvoline Oil Co., serving in that capacity until his death. He was president of the Cincinnati No. 15, of the N.A.S.E. and was a constant delegate of that association to the national association of the N.A.S.E. for about thirty years. He devoted much of his time and energy to the problems of steam operating engineers and was very highly esteemed by them. Mr. Pratt is survived by his widow and two daughters.

Mansfield Merriman, for many years professor of civil engineering at Lehigh University and author of many standard textbooks on civil engineering, died on June 7 at his home in New York City, in his 78th year. Since his retirement from professional work in 1907 he engaged in consulting work and continued his activities as editor-in-chief of the "American Civil Engineers Pocket Book." He was born in Southington, Conn., in 1848 and was graduated from Yale in 1871. Professor Merriman acted as consulting engineer on many hydraulic and bridge problems. He was a member and past-president of the American Society for Testing Materials and the Society for the Promotion of Engineering Education and a member of the A.S.C.E.

Clifton H. Wheeler, vice-president and general manager of the C. H. Wheeler Manufacturing Co., of Philadelphia, until two years ago, when he suffered a stroke, died on May 29. He was born in 1856. Owing to the death of his parents his school days were interrupted so that at the age of 15 he started to work with the exporting and importing firm of Lawrence Giles & Co. Later he formed a partnership with an old stevedore under the name of Wilson & Wheeler to handle the loading and unloading of vessels. In the year 1888 he became interested in a marine surface condenser, through his brother, who was a marine pump expert and engineer, and was imbued with its adaptability for stationary plants. After much hard work he organized the Wheeler Condenser & Engineering Co. in 1891, serving as president and general manager until 1904 for the manufacture of surface condensers. With the advent of the steam turbine came the demand for higher vacuum, and Mr. Wheeler secured the American rights for the Edwards air pump and in 1905 started building up the present company to improve and develop new types of condensers for higher vacuum. He was able later, therefore, to assist in the introduction of the successful steam air ejector in American power plants. Mr. Wheeler was a member of the A.S.M.E., Machinery Club, Manufacturers' Club and other social and industrial organizations.

Business Notes

The Republic Flow Meters Co., 2240 Diversey Boulevard, Chicago, Ill., announces the opening of a factory branch at 617 Engineers Bldg., Cleveland, Ohio. which will be in charge of L. C. Wilson.

The Mathieson Alkali Works, Inc., 250 Park Ave., New York City, announces the appointment of the A. P. Miller Supply Co., Inc., 441 West 16th St., New York City as its local distributor of "Eagle Thistle," anhydrous ammonia in the metropolitan district.

The Webster Manufacturing Co., manufacturer of mechanical handling equipment, 4500 Cortland St., Chicago Ill., announces the opening of a branch sales office at 811 Magee Bldg., Pittsburgh, Pa., which will be in charge of E. E. Landahl and the appointment of L. A. Scheck as manager of the Boston office at 902 Oliver Bldg.

The Terry Steam Turbine Co., Terry Square, Hartford, Conn., announces the appointment of C. F. Henderson, Call Bldg., as the sales representative of the company for the San Francisco, Calif., district.

The Chain Belt Company, Milwaukee, Wis., has announced the opening of a sales office at 614 Builders Exchange Bldg., Minneapolis, which will be in charge of Fred S. Van Bergen, and will cover Minnesota, North Dakota, South Dakota and parts of Iowa and Wisconsin. This office will also be the distributors for the products of the W. A. Jones Foundry & Machine Co., Chicago, the variable-speed transmissions of the Reeves Pulley Co., Columbus, Ind., and belting manufactured by the Victor Balata & Textile Belting Co., of Chicago.

Trade Catalogs

Gears—The Poole Engineering & Machine Co., Baltimore, Md. Leaflet, "Do You Know How Poole Gears Are Made," describes and illustrates the company's gears.

Grinders and Buffers—The Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin No. 1582 describes these bench-type combination grinders and buffers, with open spindle extension.

Circuit Breakers—Roller-Smith Co., 233 Broadway, New York. Bulletin No. 530, "Non-Closable on Overload, Circuit Breakers," describes these types of circuit breakers recently offered to the trade. A price list is included.

Ash and Soot Disposal—Conveyors Corp. of America, 326 W. Madison St., Chicago, Ill. "Ash and Soot Disposal at Milwaukee Sewerage Plant," is the title of a new pamphlet issued by this company. It includes a list of the equipment installed and illustrates the various parts of the system.

Drills—Sullivan Machinery Co., 122 South Michigan Ave., Chicago, Ill. Bulletin No. 80-A describes mounted diamond drills for gas engine drive; Bulletins Nos. "81-E, 81-EA" describe water-hammer drill; Bulletin No. 81-F the "Rotator" hammer drills; Bulletin No. 81-G the air-feed stoping drills.

Special Machinery — Dodge Manufacturing Corp., Mishawaka, Ind. "A Story of Big Facilities and Big Jobs" is an interesting presentation of some of the work accomplished in the building of special machinery, by this firm. The pictures tell the story of the huge pieces of machinery that are in process of building.

Gas-Engines — The Bruce-Macbeth Engine Co., Cleveland, Ohio. Bulletin 204 describes recently constructed gas engines with novel cylinder design. The cylinder is a simple casting bolted to the crankcase, and the several cylinders are incased in a cast-iron box serving as a cooling-water jacket. The cylinder heads are flanges with the necessary gas and exhaust outlets. The water surrounds the cylinders and heads, the box being open at the top. By elimination of intricate castings, danger of fractures is largely eliminated. In case of breakage, replacements are easily and cheaply effected.

Coming Conventions

American Association for the Advancement of Science, Burton E. Livingston, Smithsonian Bldg., Washington, D. C. Eightieth annual meeting at Portland, Ore., June 17-20.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at Saratoga Springs, June 22-26. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, Chalfonte-Haddon Hall, June 22-26.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Summer meeting at Salt Lake City, Utah. July 8-10.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Portland, Ore., June 22-25.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Canadian Association of Stationary Engineers. G. A. Brown, Major St., Toronto, Ont. Convention at Windsor, June 22-25.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association** at Muskegon, July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Electric Light Association. M. H. Aylesworth. 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Smoke Prevention Association—Frank A. Chambers, 1411 City Hall Sq. Bldg., Chicago, Ill. Nineteenth annual convention at Hotel Pantlind, Grand Rapids, Mich., June 17-20.

Society of Automotive Engineers, Inc. C. F. Clarkson, 29 West 39th St., New York City. Convention at Greenbrier Hotel, White Sulphur Springs, June 15-19.

Society for the Promotion of Engineering Education. F. L. Bishop, University of Pittsburgh, Pa. Meeting at Union College, Schenectady, N. Y., June 17-20.

Universal Craftsmen Council of Engineers — Twenty-third international convention in the Armory, at Akron, Ohio, August 3-8.

Switches, Starting — The Electric Controller & Manufacturing Co., Cleveland, Ohio. Bulletin No. 1048 describes type ZO starting switches for small a.c. motors. Illustrations and tables of rating are included.

Steam Heating—American District Steam Co., North Tonawanda, N. Y. Bulletin No. 181, "The Adesco System of Atmospheric Steam Vapor Heating," illustrates and describes this method of heating buildings. Pictures of buildings in which this type of service is installed are included.

Pumps—Pennsylvania Pump & Compressor Co., 50 Church St., New York City. Several bulletins have been published by this company during 1925 as follows: No. 118, "The Air Lift Method of Pumping Water by Compressed Air." contains, beside descriptive matter, illustrations, tables and data; No. 205 is "L. S. Close Coupled Centrifugal Pump"; No. 206, Centrifugal Pumps, double-action, single-stage, which is filled with illustrations and engineering information.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	June 1, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	1.57
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.85@ 2.10
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.60@ 1.75

FUEL OIL

New York—June 11, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—June 2, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—June 6, f.o.b. local refinery; 30@34 deg. fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.

Dallas—June 4, f.o.b. local refinery, 26@30 deg., $1.55 per bbl.

Philadelphia—June 5, 28@30 deg., $2.21@$2.273 per bbl.; 18@22 deg., $1.974@$2.037; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—June 8, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4¼c. per gal. light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—June 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5¾c. per gal.

New Plant Construction

Ariz., Douglas—Copper Queen Reduction Works, branch of Phelps-Dodge Corporation, will expend $1,250,000 for improvements including installation of waste heat boilers to utilize waste heat to operate the steam plant at the smelter and furnish electrical energy for Bisbee and Douglas. A Cottrell plant for recovery of copper dust will be constructed, including motors, rectifiers, insulators, transformers, etc. A. G. McGregar, Warren, is engineer.

Ark., Hot Springs—Army & Navy General Hospital will soon award contract for the construction of additions including cold storage plant. Private plans.

Ark., Jonesboro — J. F. Christy, Mgr., city water and light plant, will soon take bids on the main building of power plant including super heaters, stokers, 1,500 kw. turbine, generator, condenser and steam pipe. Total estimated cost $160,000. E. J. Wolpert, 17 American Trust Bldg., is architect.

Calif., Calipatria — The Imperial Ice & Development Co. plans the construction of a 70 ton ice plant.

Calif., Los Angeles—Hayward Hotel, H. C. Fryman, Prop., 206 West 6th St., is receiving bids for the construction of a 14 story hotel including steam heating system and elevators at 6th St. near Spring St. Estimated cost $600,000. J. and H. B. Parkinson, 420 Title Insurance Bldg., are architects.

Calif., Los Angeles—Quinby Corporation, c/o Meyer & Holler, Wright-Callendar Bldg., Archts., is having plans prepared for the construction of a 13 story office building at 7th St. and Grand Ave. Estimated cost $500,000.

Calif., Oakland — Providence Hospital, awarded contract for the construction of a 5 story hospital at Webster and Summit Sts., to Barrett & Hilp, 918 Harrison St., San Francisco. Estimated cost $750,000.

Calif., San Francisco—Hyman & Appleton, 68 Post St., Archts., are preparing preliminary plans for the construction of a 10 story apartment on Hyde St. near Larkin St. Estimated cost $500,000. Owner's name withheld.

Conn., Watertown—Watertown Mfg. Co. has had plans prepared for the construction of addition to boiler plant. Estimated cost $75,000. Fletcher-Thompson, Inc., 542 Fairfield Ave., Bridgeport, is engineer.

D. C., Washington—Dept. of the Interior will receive bids until June 17th for 2 motor driven compressors for Fairfield Intermediate Depot, Osborn, O.

Fla., Fort Myers — Broadway Building Corporation, G. Sims, Pres., is having plans prepared for the construction of a 10 story hotel and office building at Broadway and 1st St. Estimated cost $500,000. B. S. Martin, Fort Myers, and M. L. Elliott, Citizens Bank Bldg., Tampa, are architects.

Fla., Pensacola—Bureau of Yards and Docks, Navy Dept., Washington, D. C., L. E. Gregory, Chief, will receive bids until June 22nd for two 90,000 gal. steel tanks, pump house with pumping and piping at Naval Air Station, here.

Fla., West Palm Beach—R. Gambill, Graham Bldg., Jacksonville, plans the construction of two 60 ton daily capacity ice plants, here. Estimated cost $300,000 each.

Ga., Savannah—Savannah Electric Power Co., H. C. Foss, Pres., 27 West Bay St., plans the construction of addition to boiler plant at Riverside Station. Estimated cost $150,000.

Ill., Fairfield—City will receive bids about July 1st for the construction of a waterworks system including pumping equipment, etc., on Little Wabash River. Estimated cost $150,000. G. Dunbar, 419 Chemical Bldg., St. Louis, Mo., is engineer.

Ill., Great Lakes—Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until June 24th for mechanical stokers for Naval Training Station here.

Kan., Wakefield—City is having plans prepared for the construction of an additional well, pump house and pumping equipment. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are consulting engineers.

Md., Baltimore — Hebrew Hospital & Asylum Assn., Monument and Rutland Aves., awarded contract for the construction of a 7 story hospital at Monument and Rutland Aves, to M. A. Long Co., 10 West Chase St. Estimated cost $1,000,000.

Md., Baltimore—Mayor and City Council, City Hall, will receive bids until June 17th for the construction of superstructures for buildings for addition to Montebello filters, including filter building, pumping station, etc., at Harford Road and 33rd St. V. B. Siems, City Hall, is engineer.

Mass., Springfield—Eastern States Refrigerating Co., 385 Liberty St., awarded contract for the construction of a 2 story cold storage plant and factory building, including ammonia system on Liberty St. to D. W. Mellen Co., 293 Bridge St. Estimated cost $50,000.

Mass., Watertown (Boston P. O.)—Hood Rubber Co., awarded contract for the construction of a high pressure waterworks system, including pump houses to Aberthaw Co., 27 School St., Boston. Estimated cost $30,000.

Mich., Detroit—L. Kamper, 3729 Cass Ave., Archt., is receiving bids for the construction of a 10 story hotel including steam heating equipment at Woodward and Seward Aves. Owner's name withheld.

Minn., Mankato—City F. W. Bates, Clk., is having preliminary plans prepared for improvements to waterworks, including wells, pumping, mains, etc. Estimated cost $50,000. L. P. Wolff, 903 Globe Bldg., St. Paul, is consulting engineer.

Minn., Minneapolis — City Purch. Dept., F. S. Gram, Pur. Agt., will receive bids until June 24th for equipment for the Fridley pumping plant including 3 single stage, low service, centrifugal pumps, 20,000,000 g.p.d. capacity against a 43 to 45 ft. head; 3 single stage, high service, centrifugal pumps, 20,000,000 g.p.d. against a 225 ft. head; 3 electric motors with starting equipment; operating tables for each of 10 filters, etc.

Minn., St. Paul—Northern Pacific Ry. Co., Railway Bldg., awarded contract for the construction of a group of buildings including boiler house, etc., at East 3rd and Commercial Sts. to Butler Bros., 643 Hamm Bldg. Total estimated cost $750,000.

Miss., Hernando—City, S. W. Eason, Clk., plans the construction of a waterworks system including 50,000 gal. tank, pumping equipment, etc. Estimated cost $20,000.

Mo., Cassville—City plans an election June 16th to determine whether the franchise of the Cassville Electric Co. shall be extended. The Alexander Engineering Co., Woodruff Bldg., Springfield, Mo., plans to purchase and improve the electric plant if action of the citizens is favorable.

Neb., Bloomfield—City voted $50,000 bonds for the construction of a municipal light plant.

N. J., Woodbine—State Institutions and Agencies, B. C. Lewis, Comnr. Trenton, will receive bids until June 23rd for refrigeration for storehouse and cold storage equipment, here. A. B. Mills, State Office Bldg., Trenton, is architect.

N. Y., Brooklyn — Leverich Towers, c/o Starrett & Van Vleck, 393 7th Ave., New York, Archts. and Engrs., is having preliminary plans prepared for the construction of a 15 story apartment hotel, on Willow St. Estimated cost $3,000,000.

N. Y., New York—Calvary Baptist Church, Dr. J. R. Stratton, 123 West 57th St., is having preliminary plans prepared for the construction of a 12 story church and hotel at 123 West 57th St. Estimated cost $2,000,000. McKim Mead & White, 101 Park Ave., are architects.

N. Y., New York—S. W. Ehrich, 100 East 42nd St., plans the construction of a 9 story apartment at 232 East 71st St. Estimated cost $600,000.

N. Y., New York—H. A. Murray, 988 5th Ave., is having plans prepared for the construction of a 14 story apartment at 80th St. and 5th Ave. Estimated cost $1,500,000. J. E. R. Carpenter, 598 Madison Ave., is architect and engineer.

N. Y., New York—Partos Realty Corporation, c/o Rouse & Goldstone, 512 5th Ave., Archts. and Engrs., has had plans prepared for the construction of a 15 story office building at 110 West 42nd St. Estimated cost $1,500,000.

N. Y., Queens—State Hospital Comn., Capitol, Albany, will receive bids until June 30th for the construction of a cold storage plant for Brooklyn State Hospital here. S. W. Jones, Capitol, Albany, is state architect.

N. Y., Rocky Point—The Radio Corporation of America, 64 Broad St., New York, awarded contract for extension of radio central station including additions and alterations to power house, cooling pond, etc., here, to The J. G. White Engineering Corporation, 43 Exchange Pl., New York.

N. Y., St. George—Staten Island Edison Corporation, awarded contract for the design and construction of extensions to boiler house including installation of one new boiler and superheaters of 1385 hp. coal and ash handling equipment, etc., at Livingston to J. G. White Engineering Co., 43 Exchange Pl., New York.

N. C., Rocky Mount—L. L. Gravely, Mayor and Bd. of Aldermen, will receive bids until June 18th for coal handling equipment and suspension type coal bunker. W. C. Oslen, Raleigh, is consulting engineer.

O., Ashtabula—City has had plans prepared for the construction of pumping station. Estimated cost $20,000. G. B. Gascoigne, Leader-News Bldg., Cleveland, is engineer.

Okla., Ardmore — Johnson Bros. Cold Storage Co., awarded general contract for the construction of an ice manufacturing and cold storage plant to T. E. S. Nelson. Estimated cost $150,000.

Okla., Bristow—City plans an election soon to vote $45,000 bonds for waterworks system, including a deep well, pumps and pumping equipment.

Okla., Carter—M. S. Disler, is having preliminary plans prepared for the construction of a 10 ton raw water ice and cold storage plant. Estimated cost $30,000. Private plans.

Okla., Enid—Oklahoma Laundry Co., is having preliminary plans prepared for the installation of a new Diesel engine power plant. Estimated cost $30,000. J. Clover is engineer.

Okla., Kingfisher — City, J. Williams, Supt., is in the market for two 100 hp. water tube boilers for electric light plant.

Okla., Muskogee—City has had plans prepared for improvements to waterworks system including an 8,000,000 gal. filtration plant. Estimated cost $225,000. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are consulting engineers.

Okla., Norman—City voted $100,000 bonds for waterworks improvements, including pumping equipment, mains, etc.

Ore., Portland—Portland Hotel Co., 6th and Morrison Sts., will soon take bids for the construction of a 12 story hotel at 5th, 6th, Yarnhill and Stark Sts. Estimated cost $2,000,000. Architect not announced.

Tex., Wichita Falls—R. M. Waggoner et el., plans the construction of a 10 story hotel, including 3 elevators at 8th and Indiana Sts. Estimated cost $650,000.

Va., Rural Retreat—Town voted $42,000 bonds for the construction of a 200,000 gal. reservoir, centrifugal pumps, etc. A. H. Price is mayor.

Ont., Campbellford—Kerry & Chace, Ltd., Confederation Life Bldg., Toronto, Engrs., is preparing preliminary plans for the construction of a hydro-electric development including 1,000 hp. 40 ft. head vertical turbine, vertical generator, power house, transformers, pumps, etc., here, for Canadian Paperboard Co. Estimated cost $150,000.

Ont., Mactier—Village is having plans prepared for the construction of a waterworks system, including a pump house, pumps, distribution mains, etc. Estimated cost $30,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

Ont., Norman—Kewatin Power Co., Kenora, owned by Backus-Brooks Co., 1100 Builders Exch., Minneapolis, Minn., will build a 17,500 hp. hydro-electric plant, etc., at Lake of the Woods, here. Work to be done by day labor.

Ont., Toronto—Ravina Rink Co., 50 Rowland Ave., is having plans prepared for the construction of a 1 and 2 story ice hockey rink, including artificial ice equipment and steam heating system on Rowland Ave. Estimated cost $150,000. A. W. Connor & Co., Metropolitan Bldg., is engineer.

Que., Montreal—The Canadian National R.R. will soon take bids for the construction of a 26 story building. Estimated cost $2,500,000. C. S. Gzowski is chief engineer.